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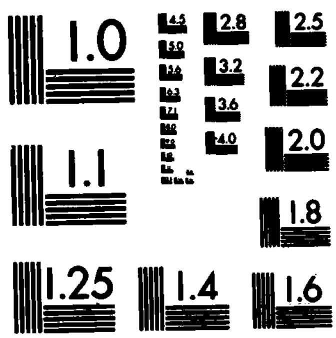

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NATIONAL AVIATION SYSTEM DEVELOPMENT AND CAPITAL NEEDS

For the Decade 1982-1991

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EXECUTIVE SUMMARY

The National Air Transportation System is facing a challenging decade of rapid growth. Even if general, national economic expansion is only modest, by 1991 civil aircraft activity will increase by over 40 percent, air carrier enplanements by over 50 percent, and commuter airline enplanements by 170 percent. To put this growth in perspective, aircraft operations will increase roughly one and one-half times as much in the coming decade as they did in the decade just ending. Investment in the air traffic control and air navigation systems, in supporting Research and Development programs, and in airport development, must keep pace with growth or system performance will suffer in terms of safety, capacity and productivity.

The excellent safety and operational record of the National Aviation System masks the fact that investment in Federal Aviation Administration (FAA) Facilities and Equipment (F&E), particularly when compared to other transportation modes, has suffered through a ten-year period of decline. While actual dollar levels have remained relatively constant, the impact of inflation has reduced the purchasing power of these dollars to barely a third of FY 1972 levels. This decline in real capital investment has left the FAA with an aging inventory of equipment, requiring ever higher levels of maintenance and continually increasing costs.

Fortunately, system performance, particularly in terms of safety, has improved over this same period through technological innovations, improved regulatory standards, a highly skilled and motivated work force, and improved management techniques by the FAA and the industry. However, while short-term improvements are expected to continue, serious deterioration in system performance is unavoidable unless capital investment levels are increased significantly.

The pattern of deferred capital investments in U.S. railroads, requiring the late infusion of significant capital, is not a suitable model for the aviation industry; but, unless the downward trend of investment is reversed, that is the direction we are heading. Continued neglect of aviation capital needs means significant costs to be paid in terms of safety, capacity and productivity. For example, if no investment is made and the system is allowed to deteriorate, it is likely that annual accident costs will rise from an average of $927 million in 1979 to an annual average of $1,222 million in 1982-86 and $1,433 million in 1987-1991, all expressed in constant 1980 dollars.

This study is a unique attempt by the Federal Aviation Administration to define the Federal investment needed to prevent such significant deterioration in system performance. At its centerpiece is the formulation of five Facilities and Equipment investment "strategies," for each of which an attempt has been made to project frankly - in terms of lives and dollars saved, and hours of delay prevented - what the general public and the aviation community will receive. The levels of F&E investments required by each strategy over the next decade vary from

$450 million to $8.5 billion in 1980 dollars. This latter figure, $8.5 billion (which is more than $14 billion in current dollars given the expected rate of inflation) is determined to be the minimum F&E investment needed to prevent serious deterioration. Using somewhat less elaborate methodology, the other investments needed to prevent this deterioration have also been defined: $1.6 billion in supporting Research and Development Programs, and $6 billion in airport development. This total Federal investment is essential, but must be complemented by other operational improvements to be fully effective. For example, the $8.5 billion F&E investment will satisfy 20 percent of the safety needs, 5 percent of the capacity needs and 13 percent of the productivity needs leaving significant challenges for FAA's developmental, regulatory and airports programs. FAA recognizes that it must continue to improve its regulatory and management techniques. Nevertheless, without a significant modernization of the physical plant, such efforts ultimately will fall short.

With the installation of major automation improvements and investments in more efficient facilities and equipment, FAA productivity will rise. Personnel requirements will increase about one percent during a decade of unparalled system growth. Some $30 billion in 1980 dollars will be needed to fund operations and staffing during the period 1982-1991.

The difficulty of the airport capacity question should by no means be underestimated. These capacity problems will be costly. Delay costs in 1980 dollars, which exceeded $500 million in 1979 at the major 24 hub airports, will reach $1.5 billion by 1986 and $8.0 billion by 1991. A 1977 FAA study estimated that as many as 19 major new air carrier airports may be needed to accommodate forecasted air traffic through the year 2000. However, a variety of reasons have precluded the development of new airports or major runway expansion at existing airports. Although congestion at these airports might be reduced by diverting general aviation aircraft to reliever airports and by developing separate, noninterfering facilities for light aircraft at major airports, eleven major airports would still have significant capacity problems by the year 2000.

Thus, while the investment requirements detailed in this report seem, at first reading, to be immense, they pale in comparison to the projected costs of accidents, delay and system inefficiency if we continue the investment patterns of the past decade. Viewed in light of the major contribution which U.S. aviation makes to both our national and international economies, the proposed investments are a small price to pay to keep that system operating efficiently and with the highest level of safety.

LIST OF FIGURES

CHAPTER I: INTRODUCTION

A. OVERVIEW. Congress has given the Federal Aviation Administration (FAA) clear statutory authority for managing the airspace of the United States. According to the Federal Aviation Act of 1958, the FAA is responsible for the efficient utilization of airspace; developing, establishing, operating and maintaining a common system of navigation; providing air navigation and air traffic control services; and for establishing aircraft and airmen requirements for operation within the system. 1/ The FAA is obviously, therefore, responsible for managing the growth-related problems the National Airspace System will experience during the next decade.

In doing so, the FAA will continue to adhere to several guiding principles. First, the FAA will continue to protect the amount of useable airspace by minimizing the effect of the restrictions necessary for the safe and efficient flow of traffic while meeting our national security and environmental needs. Second, the FAA will work to discourage the erection of obstructions which constitute hazards to aircraft or which jeopardize a Federal, state or local investment in aviation facilities. The FAA will also work with the Department of Defense to minimize national airspace restricted to military purposes.

1/ To permit the Administrator of the FAA to accomplish the purposes and objectives of Title III, Airspace Control and Utilization, and Title XII, Security Control of Air Traffic, of the FAA Act, Executive Order Number 10854 extended application of the Act to those areas of land or water outside the United States and the overlying airspace thereof over or in which the Federal Government of the United States, under international treaty, agreement or other lawful arrangement, has appropriate jurisdiction or control.

Because centralized control is the safest and most efficient, FAA utilizes a ground-based air traffic control system to ensure the safe and efficient flow of traffic. The FAA also mandates certain airmen skills and aircraft equipment in portions of airspace in which a high degree of control is required. In each case, the FAA considers the mix and sophistication of aircraft involved, the level of airspace usage, the number of people served, and other similar factors. More specifically, the provision of air navigation and air traffic control services is based upon guidelines which incorporate safety considerations and benefit/cost principles. These guidelines insure that FAA programs, such as those analyzed in this study, are at least at the minimum necessary to accomplish the agency's statutory assignment.

B. <u>AVIATION GROWTH.</u> According to official agency forecasts, the FAA-managed National Air Transportation System will experience rapid growth during the next decade. Marked increases in user demand for FAA services are predicted even when one assumes moderate economic growth, rising energy prices, and erosion of consumer purchasing power brought about by continuing inflation. As shown in Figure I-1, by 1991 user demand for terminal services is forecast to increase 40 percent, IFR en route services by 45 percent, and flight service station services by 51 percent over 1979 levels. Among the various classes of users, air taxi growth spurred by commuters [1/] is largest, followed by general aviation and air carriers. Activity growth at major airports, although at a rate below national average, is expected to be about 26 percent. The low

1/ Commuters are presently counted as part of air taxis.

growth rate for general aviation at major airports is partly the result of expected development of general aviation facilities at alternative airports, and partly the result of the anticipated imposition of demand management systems as major airports approach capacity.

FIGURE I-1
Forecast Growth In Aviation Activity
1979 To 1991
(Percent)

	All Terminals	Large Terminals (24 Major Airports)	En Route	Flight Service Stations
AC	19.2	16.4	20.0	*
AT	107.8	79.4	134.8	*
GA	40.8	12.8	85.2	*
Total	40.3	25.8	45.0	51.4

Source: FAA Aviation Forecasts: Fiscal Years 1981-1992, and Terminal Area Forecasts, November 1980

*Not Available

AC = Air Carrier
AT = Air Taxi, Including Commuters
GA = General Aviation

The rate of passenger growth is forecast to be substantially higher than that of activity. As can be seen in Figure I-2, by 1991 nationwide air carrier enplanements are expected to rise by 61 percent over 1979 levels, with commuter enplanements growing about 170 percent. This reflects the shift to larger aircraft by both air carriers and commuters as well as higher load factors — projected results of airline economic deregulation and the changing character of the fleet. As with activity, enplanement growth at large terminals is expected to be less than for the nation as a whole. The larger levels of growth at smaller airports reflect expansion of commuters in serving small and medium size communities.

FIGURE I-2
Forecast Growth In Enplanements
1979 to 1991
(Percent)

	Total	Large Terminals (24 Major Airports)
Air Carriers	61.2	48.8
Commuters	170.2	144.6

Source: FAA Aviation Forecasts: Fiscal Years 1981-1992, and Terminal Area Forecasts, November 1980

C. DEVELOPMENT AND CAPITAL NEEDS. It is difficult to identify the future capital needs of the National Airspace System in an environment of severely changing costs. One problem encountered in formulating a long-range estimate has been that of accurately defining system performance generated by various levels of funding and staffing. System performance benefits expected from alternative levels of capital investment have not been accurately defined. Nor, for that matter, has the point where system saturation with minimum capital funding and essentially constant staffing been defined.

This study attempts to correct those shortcomings and to estimate the capital and staffing needs necessary to handle forecasted growth during the 1982-1991 decade. With respect to Facilities and Equipment (F&E) investments, five investment strategies for the air traffic control and air navigation systems have been formulated. Using existing, rough and very conservative estimates, benefits have been calculated for each strategy in terms of safety, capacity and productivity, measured by dollars, lives saved and hours of delay prevented. While the details of these strategies are contained in Chapter III, their titles, and total costs and benefits measured in constant 1980 dollars are as follows:

	Total Costs ($ - Millions)	Safety Benefits ($ - Millions)	Cumulative 2/ Benefits ($ - Millions)
"Physical Wear Out"	$ 446.5	$ 98.8	$ 391.9
"Economic Replacement"	4,005.9	371.8	389.0
"Expansion - Existing Technology"	6,576.4	1,138.9	6,336.2
"Expansion - New Technology"	7,739.4	1,636.8	7,968.3
"Quality Improvement"	770.6	346.5	812.8
TOTAL 1/	$ 8,510.0	$ 1,983.3	$ 8,781.1

As a result of formulating these strategies, it emerges that the minimum investment in F&E necessary to prevent deterioration in system performance is approximately $8.5 billion (1980 dollars).

1/ Total includes only "Expansion—New Technology" and "Quality Improvement" and is cumulative in that "Expansion—New Technology" includes all previous alternatives.

2/ Benefit/cost ratios cannot be accurately computed from the data shown. Cumulative benefits represent only those which accrue during the 1984-91 time period and do not include life cycle payoffs beyond 1991. Similarly, costs shown do not include life cycle components such as operation and maintenance costs.

There are additional important funding requirements as well. Research and Development resource needs have been estimated by including those efforts which will result in new or enhanced navigation, and communication or radar facilities during the 1982-1991 decade. Engineering and development capital needs have been estimated by including those new initiatives that should be implemented after 1991. The total Research, Engineering and Development need for the coming decade is $1.6 billion of 1980 dollars. Finally, the level of investment in airport development has been estimated based on the Administration's proposed "Airport and Airway Development Act of 1979," which is now being considered by Congress. This proposed legislation would extend only through 1985; but, if the funding trend were extended through 1991, the Federal expenditures would total approximately $6 billion (1980 dollars) over the 1982-1991 period.

This composite picture of basic investment needs provides a reasonable appraisal of what the Federal government must invest during the next ten years to prevent a significant deterioration of system performance. This is not a benefit-cost analysis of any single program, however, the agency's System Acquisition Management (SAM) process will ensure that each individual investment program will be cost-effective. Moreover, the agency also recognizes that continued improvements in technology, management and regulatory techniques need to be made.

In addition, it is important to note that even if all of these investments are made and planned programs in air traffic control, navigation facilities and airport development are completely successful, significant shortfalls in capacity will occur at a number of airports. A study completed by the FAA in 1977 predicted that as many as 19 major new air carrier airports would be needed to accommodate forecasted air traffic growth through the year 2000. As many as 14 major airports may reach capacity limits by 1990, and this number may grow to 19 by the year 2000. Attempts to deal with this problem by diverting general aviation aircraft to reliever airports and by developing separate facilities for light aircraft at major airports, may reduce this number to 11. Nevertheless, we are clearly approaching a constrained system in high density terminals where quotas or pricing mechanisms may be necessary to limit demand if the required capacity cannot be provided.

D. SYSTEM PERFORMANCE. System performance is best measured in terms of safety, capacity and productivity. Performance in all three areas clearly reflects the capital investments made in air traffic control and air navigation facilities, and in airport improvements. For example, the accident records for both air carrier and general aviation have improved markedly over the past decade, partly because of previous investments in new and improved navigation, communication and radar facilities, investments in airport development, and technological and regulatory improvements by the FAA and industry. However, the utility of those investments will be stressed by projected growth to the point where system performance will suffer. It is estimated that if no new investments are made, the annual accident costs will increase from an average of $927 million in 1979, to an annual average of $1,222 million during 1982-1986, and $1,433 million during 1987-1991.

The system will also suffer in terms of capacity. Air traffic control system generated delay costs, if unmitigated by system investments, are forecasted to reach $1.9 billion by 1986 and $8.0 billion by 1991 compared to $500 million during 1979 (all in 1980 dollars) at the 24 major hub airports. These delay costs represent lower bounds of actual delay costs that would be incurred if no capital investments were made and no other effective measures were taken to reduce delays.

Finally, the growth in system productivity will decline. This is an area like aviation safety which has shown significant improvement over the last decade. In the future, increases in efficiency will, however, require additional investment. By 1991, FAA operating costs are expected to increase to an annual cost of over $4 billion. This increase will result in substantially higher unit costs despite efforts to squeeze ever increased output from existing facilities.

E. STUDY OUTLINE. Chapter II describes current system performance in terms of safety, productivity and capacity, and forecasts aviation growth and certain system improvements.

Chapter III (1) compares recent levels of investment for all transportation modes; and (2) assesses current levels of investment in air traffic control, air navigation and airports. Five investment strategies for Facilities and Equipment are established, along with overall investment requirements for Research and Development and Airport Development. Costs and benefits are established for each. Airport capacity problems are also forecasted.

Chapter IV presents a basic outline of FAA programs and is followed by a glossary of abbreviations.

Appendix I contains an outline of the specific programs described in Chapters III and IV. Minor adjustments in the timing of a few of these programs have been made since completion of the Chapter III analysis. With this exception, the programs are consistent with those included in Chapter III.

Appendices II and III contain a complete description of the Research, Engineering and Development (R,E&D) program activities, major milestones and fiscal planning.

CHAPTER II: NATIONAL AVIATION SYSTEM USAGE

A. OVERVIEW. According to current forecasts, aviation activity is predicted to grow over the next decade. In fact, the level of operations may well grow more in the coming years than it did during the 1970's. Resolution of problems relating to national economic growth, energy, airport environment and economic regulations will help determine the pace of such growth in the years ahead. In turn, the successful meeting of aviation system needs will feature heavily in how efficiently the Nation solves its economic, energy and environmental problems.

The basic thrust of this chapter is to relate aviation growth to the existing performance of the National Airspace System (NAS). Specifically, the NAS baseline will be described in terms of the Airport and Air Traffic Control System. Past system loading is described in terms of aviation activity, and the levels of safety, capacity and productivity achieved by aviation users and the FAA. This chapter presents forecasts of future NAS aviation activity, with its conclusion being a glimpse of the future NAS in 1986 and 1991.

B. SYSTEM BASELINE. Plans for the future of the National Airspace System (NAS) are based on the existing network of airports, air traffic control facilities, aircraft activity and the ability of the system safely to handle demands on the system.

(1) Airport System. There were 14,746 airports (including heliports, seaplane bases, and STOL ports) in the United States and its possessions at the beginning of 1980. This total may be misleading,

because it includes 8,087 private use airports from which the general public is excluded, as well as many airports that are relatively undeveloped and infrequently used. The most active facilities, from a public transportation viewpoint, consist of approximately 2,800 airports which are publicly owned, open for general use, and which have at least one paved and lighted runway.

Most of these public airports serve only general aviation aircraft. Less than 450 are regularly served by large air carrier aircraft 1/ and, even at these airports, general aviation often accounts for the bulk of the operations. Air carrier activity is concentrated at the metropolitan airports that serve as airline passenger transfer points. These locations are called hubs because airline routes radiate out from them like the spokes of a wheel. The 25 busiest hubs account for about two thirds of all air carrier passenger enplanements, and the busiest 100 hubs account for more than 90 percent. Air carrier activity is generally light at nonhub airports. As an illustration, the 400 least active air carrier airports combined account for fewer enplaned passengers than does Chicago O'Hare.

(2) Air Traffic Control System. The basic purpose of air traffic control is to provide for the safe and efficient use of airspace. Two methods are currently employed to provide protection against collisions

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1/ In addition, there are about 200 airports in Alaska that are served by small airline aircraft, and about 150 airports in the conterminous United States that have a significant amount of commuter airline type activity.

between aircraft: (a) the visual flight rule (VFR) - "see and avoid" concept supported by appropriate procedures wherein the pilots are responsible for collision avoidance; and (b) the Instrument Flight Rule (IFR) environment wherein collision avoidance is primarily the responsibility of the Air Traffic Control (ATC) system. (A pilot operating on an IFR clearance in visual meteorological conditions has the responsibility to "see and avoid.")

To describe its functions, the ATC system can be divided into three categories: En Route, Terminal and Flight Services.

a. En Route. En route services are provided in the airspace over the continental United States from 20 FAA facilities known as Air Route Traffic Control Centers (ARTCC's). Two other ARTCC's provide en route air traffic control services in Alaska and Hawaii. Combined Center/Radar Approach Control (CERAP) facilities on Guam and San Juan, Puerto Rico, provide en route Air Traffic Control (ATC) services in those areas.

The radar surveillance data required to provide these services are derived from 104 long-range Air Route Surveillance Radars (ARSR's) and 11 secondary radar sites (Beacon only sites). En route remote center air-ground (RCAG) communications are provided by about 500 installations. Ground to ground and internal communication capabilities are mainly provided with leased equipment and systems.

A ground based network of 927 Very High Frequency Omni Ranges (VOR's) provides the basic means of electronic navigation. An elaborate airway system consisting of 398,500 miles has been established using the VOR network for guidance.

b. <u>Terminal.</u> The FAA's inventory of terminal facilities is comprised of installations providing three different levels of air traffic control services: Visual Flight Rules (VFR) assistance from airport traffic control towers (ATCT's); nonradar approach control ATCT's; and radar approach control facilities.

VFR towers, of which there are 199, are established at qualified airports to provide air traffic control services to VFR aircraft operating on or in the vicinity of the airport.

In the second category, there are 59 nonradar approach control towers. This type of facility provides for separation of Instrument Flight Rules (IFR) aircraft operating in its terminal area. This service is provided through procedures directed from the tower cab and is based on specified time, horizontal and vertical separation standards.

The third level of service provided by terminal facilities is radar approach control; 185 of these facilities are in operation.

FAA has adopted two noteworthy methods of dealing with heavy traffic congestion or unknown aircraft in major terminal areas:

- Terminal Radar Service Area (TRSA) - Airspace surrounding designated airports wherein ATC provides radar vectoring, sequencing and when possible separation services on a full-time basis for all IFR and participating VFR aircraft. As of October 1, 1980, 135 TRSA's were in operation.

- Terminal Control Area (TCA) - Controlled airspace extending upward from the surface to specified altitudes, within which all aircraft are subject to specific operating rules and pilot and equipment requirements. The specific operating requirements in a TCA are specified in FAR Part 91. As of October 1, 1980, 22 TCA's were in operation.

Other FAA owned and maintained terminal facilities consist of electronic and visual terminal aids to provide accurate approach and landing guidance. These systems include 621 commissioned precision Instrument Landing Systems (ILS's) at 430 airports as of August 31, 1980, that provide both horizontal and vertical electronic guidance during varied visibility conditions without compromising safety. In addition there are 829 Visual Approach Slope Indicators (VASI's) to visually provide the pilot glide slope information which is provided electronically by the ILS, and 577 approach lighting systems to assist pilots during low level visibility conditions as well as taxiway and runway lighting systems used during all weather conditions.

c. Flight Services. Three hundred and nineteen (319) Flight Service Stations provide weather and aeronautical information services primarily to general aviation pilots. These services include: flight plan processing, preflight and inflight weather briefings, en route communications, and emergency services such as assistance to lost aircraft.

C. PAST AIR TRAFFIC SYSTEM LOADING.

(1) System Loading. Each air traffic control function (en route, terminal and FSS) has experienced continuous growth during the past five years.

a. En Route. Over the last five years, Air Route Traffic Control Center (ARTCC) activity has been increasing at a rate of approximately five percent per year. Overflights have been increasing slightly more rapidly than departures, indicating a trend towards longer flights. Total activity from 1975 through 1980 is expected to increase by 27.5 percent.

ARTCC Activity
(Millions)

	FY-1975	FY-1979	Ave. Ann. % Change	Estimate FY-1980	FY 75-80 % Change
IFR Aircraft Handled	23.6	29.9	6.1	30.1	27.5

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

b. Terminals. In the last five years, total aircraft operations at airports with Airport Traffic Control Towers (ATCT's) have annually increased some 4.0 percent while instrument operations averaged annual increases of 8.5 percent. In FY-1980, instrument operations are expected to continue this rapid increase while aircraft operations are expected to decrease slightly. During the 1975 through 1980 period, aircraft operations are expected to increase a total of 17.1 percent and instrument operations 38.7 percent.

ATCT Activity
(Millions)

	FY-1975	FY-1979	Ave. Ann. % Change	Estimate FY-1980	FY 75-80 % Change
Aircraft Operations	58.9	69.0	4.0	68.6	17.1
Instrument Operations	26.1	36.2	8.5	38.7	38.7

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

c. Flight Services. The following statistics include flight services provided by domestic Flight Service Stations (FSS's), international FSS's, and combined station/towers (CS/T's). Domestic stations provide more than 95 percent of all services, and CS/T's less than one percent. Total flight services have been increasing at a rate of 3.4 percent per year over the last five years. Of the various activities included in flight services, IFR flight plans have increased most rapidly, while VFR flight plan filing has decreased. These trends are forecast to continue in FY-1980. The overall increase in total flight services provided from 1975 through 1980 is projected at 12.2 percent.

FSS Activity
(Millions)

	FY-1975	FY-1979	Ave. Ann. % Change	Estimate FY-1980	FY 75-80 % Change
Total Flight Services	58.3	66.6	3.4	65.4	12.2

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

(2) Distribution of Workload By User Category

a. En Route. Traditionally, the majority of the activity handled by centers has been air carrier. This majority has eroded in recent years as more air taxi (which includes commuters) and general aviation flights file IFR flight plans. Air taxi activity has been increasing at an annual rate of over 15 percent and general aviation at 12.5 percent. Therefore, while air carrier operations have increased over the last five years, in face of the tremendous growth in other categories, their percentage of the total has decreased from 52.5 in FY-1975 to 46.8 in FY-1979. The military share has also decreased during this period.

IFR Aircraft Handled By User Category
(Millions)

	FY-1975	FY-1979	Ave. Ann. % Change	Estimate FY-1980	FY 75-80 % Change
Air Carrier	12.4	14.0	3.1	13.9	12.1
Air Taxi	1.3	2.3	15.3	2.5	92.3
General Aviation	5.5	8.8	12.5	9.0	63.6
Military	4.4	4.8	2.2	4.7	6.8

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

Percent of Total Aircraft Handled By User Category

	FY-1975	FY-1979	Estimate FY-1980
Air Carrier	52.5	46.8	46.2
Air Taxi	5.6	7.8	8.3
General Aviation	23.4	29.5	29.9
Military	18.5	15.9	15.6

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

b. Terminals. The mix of major tower cab workload has changed little in recent years; about 75 percent for general aviation and 15 percent for air carrier. However, the air taxi share has increased rapidly while the military share has declined. The IFR room workload has been changing dramatically along the same lines as the center workload, with high rates of increase for air taxi and general aviation.

Aircraft Operations By User Category
(Millions)

	FY-1975	FY-1979	Ave. Ann. % Change	Estimate FY-1980	FY 75-80 % Change
Air Carrier	9.4	10.4	2.6	10.3	9.6
Air Taxi	2.7	4.4	13.0	4.7	74.1
General Aviation	44.2	51.7	4.0	51.1	15.6
Military	2.7	2.5	-1.9	2.5	-7.4

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

Instrument Operations By User Category
(Millions)

	FY-1975	FY-1979	Ave. Ann. % Change	Estimate FY-1980	FY 75-80 % Change
Air Carrier	9.5	10.7	3.0	10.6	11.6
Air Taxi	1.9	3.7	18.1	4.2	121.1
General Aviation	10.7	17.9	13.7	19.6	83.2
Military	3.9	3.9	0.0	4.3	10.3

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

Percent of Total By User Category

	Aircraft Operations			Instrument Operations		
	FY-1975	FY-1979	Estimate FY-1980	FY-1975	FY-1979	Estimate FY-1980
Air Carrier	15.9	15.1	15.0	36.6	29.6	27.4
Air Taxi	4.6	6.3	6.9	7.1	10.1	10.9
General Aviation	74.9	74.9	74.5	41.1	49.4	50.6
Military	4.6	3.7	3.6	15.2	10.9	11.1

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

c. Flight Services. The only activity measured by user category in the Flight Service Station (FSS) is aircraft contacted. General aviation accounts for about 80 percent of the activity, and this percentage has changed little over recent years. There has been some increase in air taxi activity and some decline in military activity.

Aircraft Contacted By User Category
(Millions)

	FY-1975	FY-1979	Ave. Ann. % Change	Estimate FY-1980	FY 75-80 % Change
Air Carrier	.4	.4	0.0	.4	0.0
Air Taxi	.7	.9	6.4	.9	5.1
General Aviation	8.1	8.4	1.0	8.1	0.0
Military	.7	.4	-13.7	.4	-5.8

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

Percent of Total By User Category

	FY-1975	FY-1979	Estimate FY-1980
Air Carrier	4.8	5.0	4.7
Air Taxi	8.3	10.2	10.4
General Aviation	80.0	80.5	80.2
Military	6.9	4.3	4.7

Source: FAA Aviation Forecasts, Fiscal Years 1981-1992

(3) Geographical Distribution of Workload

a. En Route. Although aircraft activity varies geographically throughout the conterminous United States, centers have been located and configured in a manner which provides a relatively uniform distribution of workload. In 1979 the six centers which serve the area which used to be called the Golden Triangle (the area bounded by lines drawn from Chicago to Boston to Washington, D.C. to Chicago) handled about 35 percent of the workload, compared to the forecast of about 30 percent (6 of 20 centers). Military activity is heavily concentrated in the Sun Belt.

b. Terminals. The heaviest concentration of tower cab activity is in California. The FAA Western Region alone, which comprises the States of California, Nevada and Arizona, has over 21 percent of the total. The IFR room activity, however, mirrors that of the en route centers. The three regions included in the Golden Triangle (New England, Eastern and Great Lakes) collectively experienced about 36 percent of the total FY-1979 activity.

c. Flight Services. Flight Service Station (FSS) activity is also distributed relatively evenly throughout the nation, except that Alaska has a much higher percentage of FSS activity than it does in the en route or terminal facilities. FSS activity is also somewhat higher in the FAA Central, Southwest and Rocky Mountain Regions and is considerably lower in the Western Region.

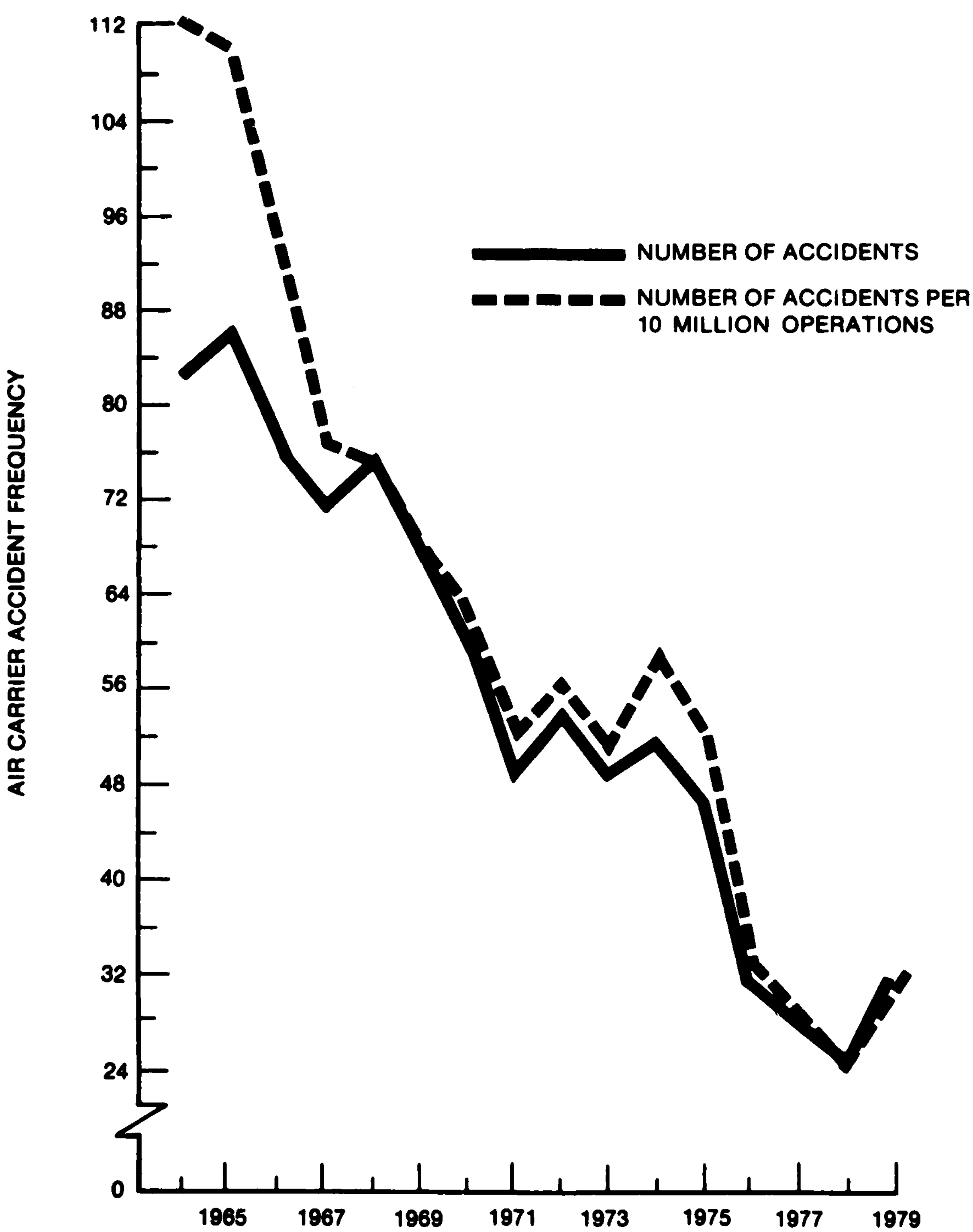
D. NATIONAL AIRSPACE SYSTEM PERFORMANCE. The existing air traffic control and navigation system generates specific levels of performance in terms of safety, capacity and productivity, and in terms of environmental and energy impacts. Capital investments in facilities and equipment (F&E) or the lack thereof will, over time, substantively affect these performance levels. The following sections address safety, capacity and productivity -- the three categories of primary interest in F&E investments.

(1) Safety. As illustrated in Figures II-1 and 2, both air carrier and general aviation accident records have shown marked improvement over the years. Contributing to this improvement have been capital investments previously made in both facilities and equipment and airport development. The latest data indicate that general aviation safety performances are continuing to improve. In effect, this data shows the current system baseline insofar as safety is concerned.

In the absence of any system improvement, modernization, or other change which would decrease accident rates, total accidents and costs related to these accidents would be expected to increase over time as aviation activity goes up. Increases in accident costs have been projected using existing accident rates and activity forecasts — results are shown in Figure II-3. For the 1982-86 time frame, annual accident costs would average $1,222 million versus $927 million for 1979; in the

Figure II-1

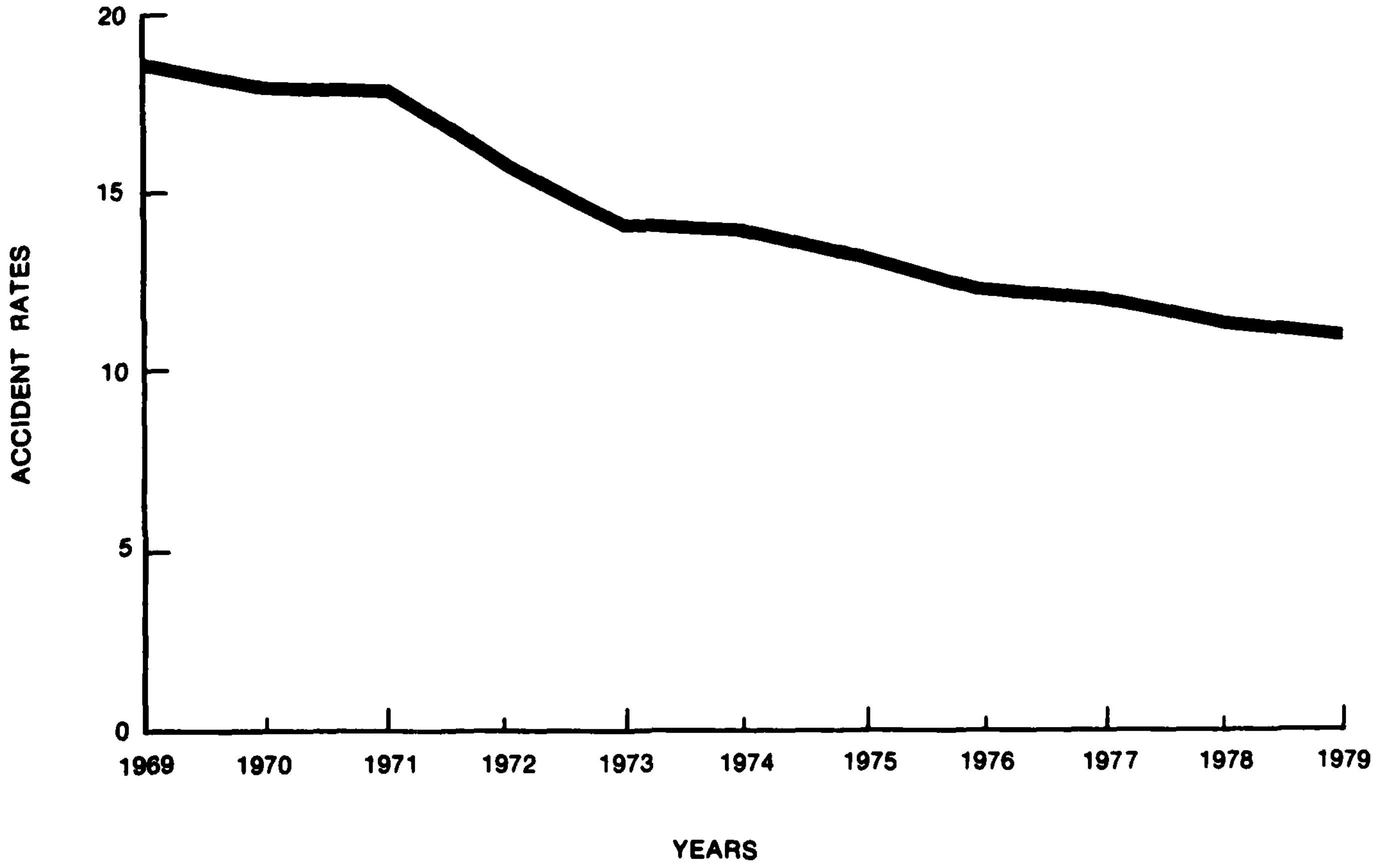
AIR CARRIER ACCIDENT HISTORY*
(JANUARY 1964 THROUGH DECEMBER 1979)



*INCLUDES FATAL AND NONFATAL ACCIDENTS.

Figure II-2

GENERAL AVIATION ACCIDENT HISTORY*
(ACCIDENT RATES PER 100,000 AIRCRAFT-HOURS FLOWN)



*INCLUDES FATAL AND NONFATAL ACCIDENTS.

1987-91 time period, they would reach an annual average of $1,433 million. In reality, these costs would likely be much higher since accident rates might well increase in the absence of the modernization of the system. Moreover, since activity is forecast to grow at a greater rate at smaller airports, which have less capital equipment and thus may have higher accident rates, overall average accident rates might be compounded in the absence of system improvements.

For estimating purposes, then, projections shown in Figure II-3 represent accident costs that would be expected for the 1982-91 time frame, using current accident rates and forecasted level of aircraft activity. However it should be noted that the impact which regulatory improvements may have on accident rates is not included in this analysis.

FIGURE II-3
Accident Costs
(Millions of 1980 Dollars)

Period	Air Carrier	Air Taxi Commuters	General Aviation	Total	Average Yearly Costs
1979	$112	$ 81	$ 734	$ 927	$ 927
1982-86	$632	$542	$4,937	$6,111	$1,222
1987-91	$680	$642	$5,843	$7,166	$1,433

Source: Federal Aviation Administration, APO-100

Although accident causal factors indicate pilot error and weather to be responsible in the majority of accidents, a conclusion should not be drawn that F&E expenditures will only serve to reduce the relatively few accidents attributable to or contributed by deficiencies in facilities and airports. For instance, the degree to which the flight crew became overextended because of weather or lack of facilities may not always be clear. It is clear, however, that IFR and VFR landing aids will transform what might otherwise be a "black hole" or "sea of lights" into a more easily identified airport environment which can assist the crew to avoid what might otherwise be recorded as a "pilot error" or "weather" related accident.

This example can be applied across the entire spectrum of facilities. It is not possible to quantify the total safety contribution of F&E facilities in accident statistics because the accident that did not happen is not in itself a statistic, and when it does happen, it will be because of multiple causes. It is also expected that additional facilities will serve to reduce accidents in the other causal factors beyond those charged to airports and facilities.

(2) Capacity. Lack of capacity to satisfy demand placed on the air traffic control and airport systems can be measured in delay costs sustained by system users. Estimates of such costs vary widely; for purposes of this study, costs shown in Figure II-4 will be used.

FIGURE II-4
Air Carrier Delay Costs At 24 Major Airports
(Millions of 1980 Dollars)

Period	Air Carrier Industry	Passengers	Totals	Average Yearly Costs
1979	$ 334	$ 238	$ 572	$ 572
1982-86	$ 5,172	$ 4,560	$ 9,733	$1,947
1987-91	$19,459	$20,718	$40,177	$8,035

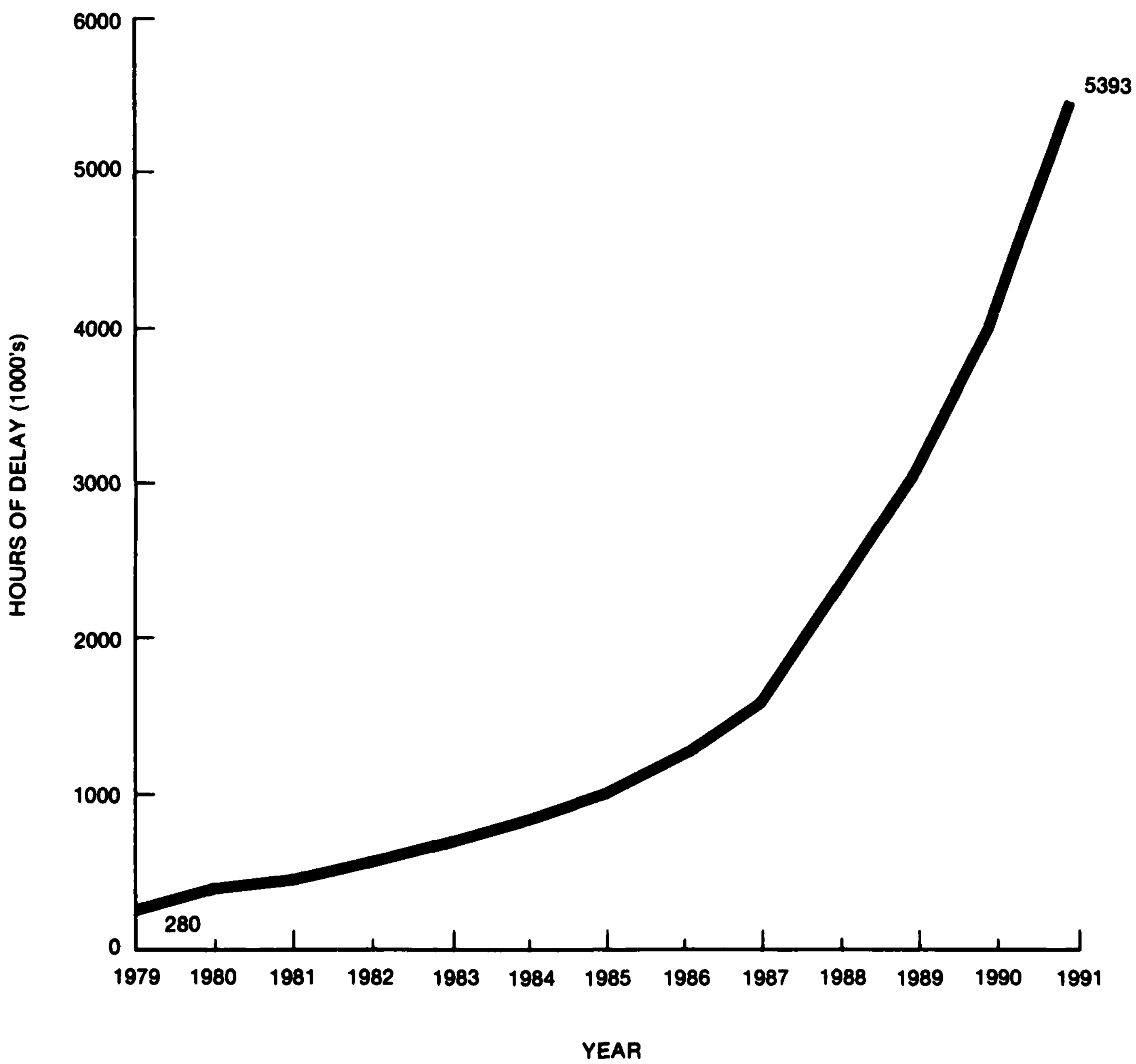
Source: Federal Aviation Administration, APO-100

These costs are based on estimated delays at the twenty-four major airports analyzed in a 1977 FAA study. 1/ They have been updated to reflect current forecasts of operations and enplanements and include an assumption that air carriers will not, on their own accord, restrict demand at congested airports. These delays are shown in Figure II-5. The 1979 estimate of $572 million (1980 dollars) represents the system baseline for capacity. Baseline capacity is the level of performance achieved by the system as it exists today, with its related complement of facilities, sensitivities to weather, and existing congestion problems. The 1982 to 1986, and 1987 to 1991 estimates, which average $1.9 billion and $8.0 billion respectively on an annual basis, represent lower bounds of actual delay costs that would be incurred if no capital investments were made and no other effective measures were taken to reduce delays. There are certain qualifications about these costs. First, these costs are based on estimated delays at only 24 airports (approximately one half of system delay is generated at these airports). Second, general aviation costs are excluded. Partially offsetting these factors, however, is the prospect that rising delays and costs would probably cause the airlines to adjust their schedule so as to reduce delays. Nevertheless, although measured delay might be thus reduced, real economic costs might not go down because such airline rescheduling would result in a less than desired use of the flying public's time.

1/ "Establishment of Major Public Airports In The United States" August 1977

FIGURE II-5

PROJECTED HOURS OF DELAY AT 24 MAJOR AIRPORTS

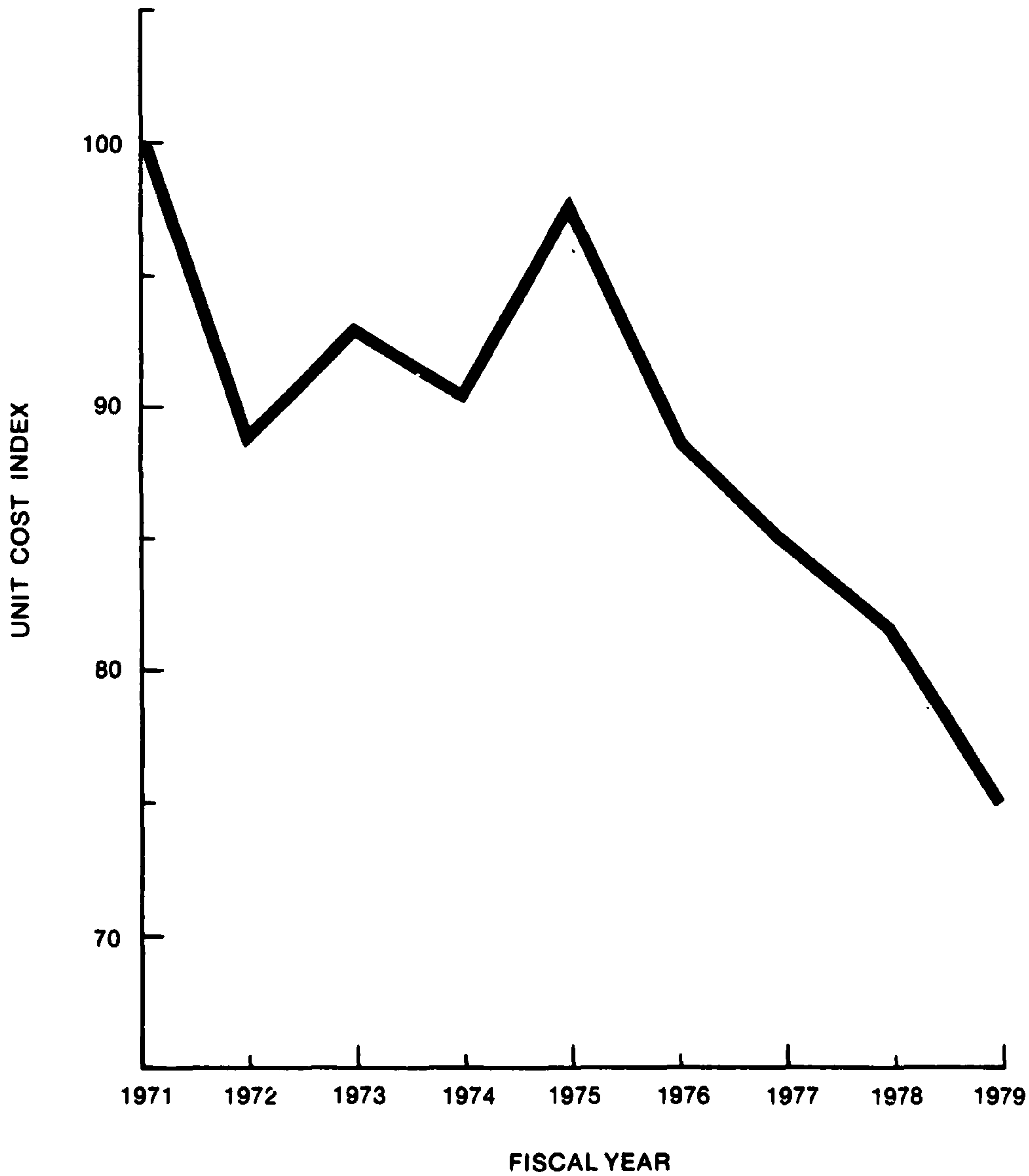


(3) <u>Productivity.</u> Productivity is a measure of the efficiency with which the FAA serves its users. Changes in productivity can be assessed as shown in Figure II-6, which presents an index of FAA unit cost since 1971. The index is computed by relating the ratio of agency operating cost (in constant dollars) to an index of agency output, and normalizing the ratio so that 1971 equals 100. Although unit operating cost has fluctuated, it has declined by about 25 percent since 1971. But at the same time, the index of agency output has also experienced irregular decline as a result of lagged increases in agency hiring in response to demand growth, and fluctuations in demand for agency services caused by changes in overall economic activity.

The decline in agency unit operating costs has in part been due to previous capital investments which have reduced the need for maintenance and operating personnel. Further declines in costs can be expected in the immediate future as a result of capital projects now being undertaken to take advantage of the maintenance savings from solid state technology. Over the longer term, however, additional investment will be required to increase or just maintain the current level of efficiency. Projections of agency operating costs are shown in Figure II-7 for the 1982-86 and 1987-91 periods. Based on activity forecasts, average annual costs (expressed in 1980 dollars) rise to $3,308 million in 1982-86 and $4,174 million in 1987-91. As with any production process, attempts to squeeze ever increased output from an unimproved system will eventually result in higher unit costs. Since the projection procedure employed here assumes only two percent annual unit cost

FIGURE II-6

PRODUCTIVITY INDEX
MEASURE OF FAA COST PER UNIT OF OUTPUT
(1971 = 100)



NOTE: CONSTANT DOLLARS

increases, these estimates, like the accident and delay cost projections, are lower bounds of the true costs which would be expected to prevail if little or no capital investments were undertaken.

FIGURE II-7
FAA Operations Appropriations
(Millions of 1980 Dollars)

Period	FAA Operations Cost
1979	$ 2,187
1982-86	$ 16,538
1987-91	$ 20,870

Source: Federal Aviation Administration, APO-100, and FAA Statistical Handbook of Aviation

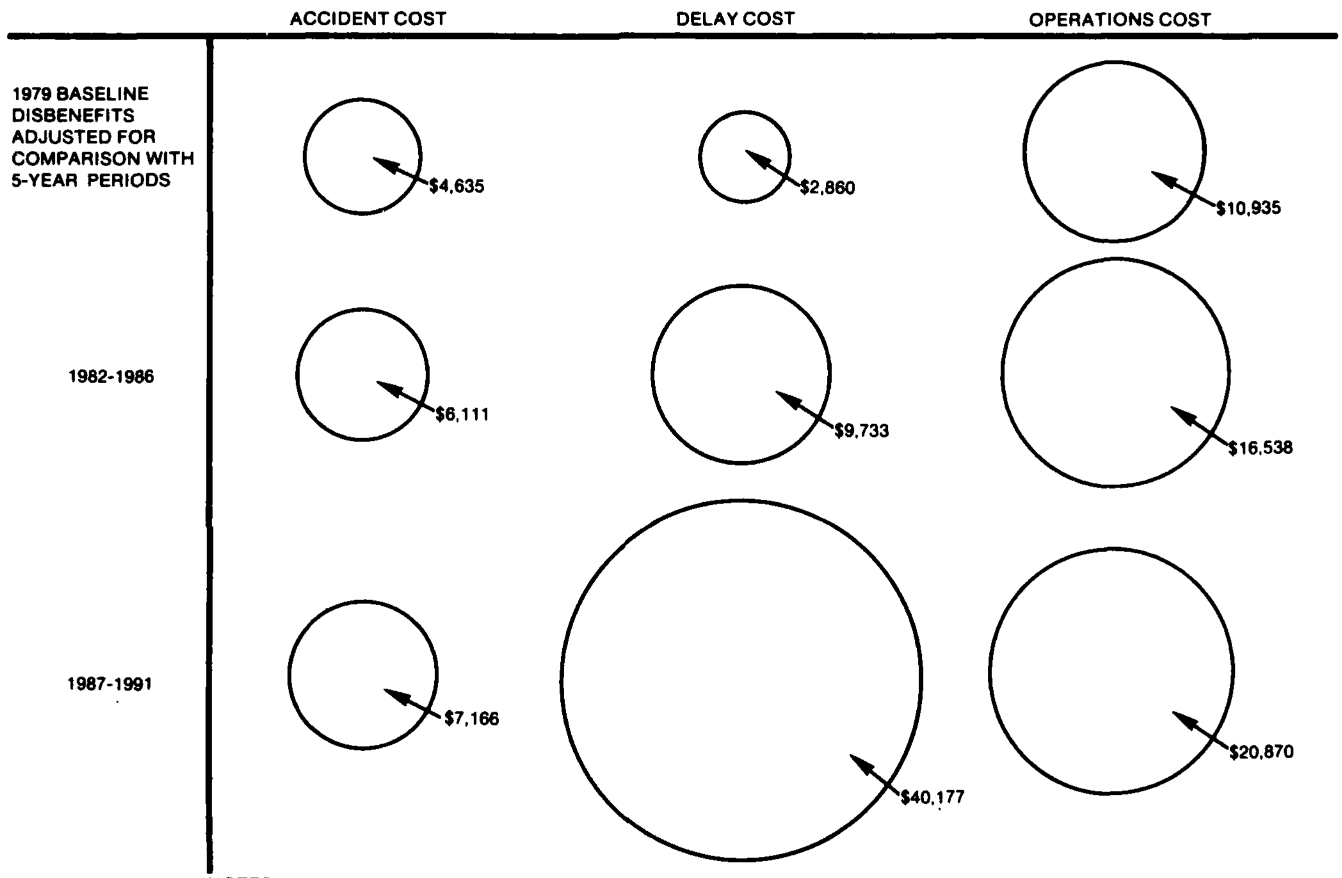
(4) Summary. Lower bound cost projections associated with each indicator of system performance are summarized in Figure II-8. Also shown are the respective 1979 levels, adjusted to make them comparable with the five year periods of the projections. Although the growth in each of the three cost components results primarily from increased traffic, it nonetheless represents a decline in system performance because there are capital investments that could be made that would improve system performance by more than the cost of the investments themselves. These capital investments are outlined in Chapter IV.

E. FUTURE LOADING.

(1) Plans and Forecasts. Plans for the future of the National Airspace System are a function of forecasted aviation activity which, in turn, are based upon estimated national economic conditions.

FIGURE II-8

INDICATORS OF SYSTEM PERFORMANCE ASSUMING NO CAPITAL EXPENDITURES



NOTES:

1. IN MILLIONS OF CONSTANT 1980 $'s.
2. THE CIRCLES REPRESENT THE DOLLAR DISBENEFITS ACCRUED IF NO CAPITAL INVESTMENTS ARE MADE FOR EXPANDED, NEW OR MODERNIZED FACILITIES.

The baseline forecasts are based on the assumption that the current relationship of the Federal Government to the aviation industry remains essentially unchanged during the forecast period. That is, deregulation, as set forth in the Act, will be accomplished; noise and pollution standards will continue to be implemented; and there will be no new environmental or policy constraints on aviation.

The economic projections used in developing the FAA baseline aviation forecasts were prepared from the Wharton Long-Term Industry and Economic Forecasting Model. The principal Wharton series used in the forecasts are presented here. Specific assumptions used in the individual models are discussed in the following pages.

Wharton has forecast that gross national product will grow in real terms, i.e., adjusted for inflation, at an average annual rate of 2.7 percent throughout the forecast period. This compares with an average rate of 3.1 percent over the last five years.

Employment is expected to increase from 96.0 million in 1979 to 114.2 million by 1992 at an average annual rate of 1.3 percent. The latter is somewhat below the previous ten year rate because a shift in the age distribution of the population indicates that fewer people will be entering the labor force.

The unemployment rate declined to 5.9 percent in 1979 from a peak of 7.7 percent reached during the 1974-1975 recession. It is assumed that the rate will increase in 1980 and 1981 and then decline to 5.0 percent by 1992. Consumer prices are forecast to continue to rise, but at a rate considerably below the 1979-1980 rate. It is assumed that the consumer price index will rise 11.7 percent in 1981. However, by 1992 the rate of increase will slow to 7.3 percent.

Disposable personal income, in 1972 dollars, is expected to grow at a moderate 2.8 percent rate, from $997.2 billion in 1980 to $1,384.4 billion in 1992. Consumption patterns will continue to shift as rising energy and fuel costs take a higher percentage of disposable income.

Fuel prices, based on the Wharton projection of the oil and gas deflator, are forecast to increase by 225 percent between 1980 and 1992. The FAA baseline forecast assumes the general availability of fuel for aviation. The only rationing mechanism used in developing the activity forecasts is that of price.

(2) <u>Ten Year Outlook.</u> Virtually no increase in most aviation activity levels is expected in the short-term until the economy recovers from the current recession. As a result, this year's (1980) forecasts reflect somewhat less growth over the next 12 years than the forecasts published in 1979. Overall, the long-term outlook is for relatively stable growth which during the forecast period will be at a faster rate of growth than the general economic activity.

a. <u>Aviation Activity.</u> Domestic air carrier revenue passenger enplanements are expected to increase by 60 percent and revenue passenger miles by 75 percent in the period from 1980 through 1992. Air carrier operations are expected to increase by only 21 percent during the same period, reflecting a continuing trend to aircraft with greater seating capacity, higher load factors, and longer average stage lengths.

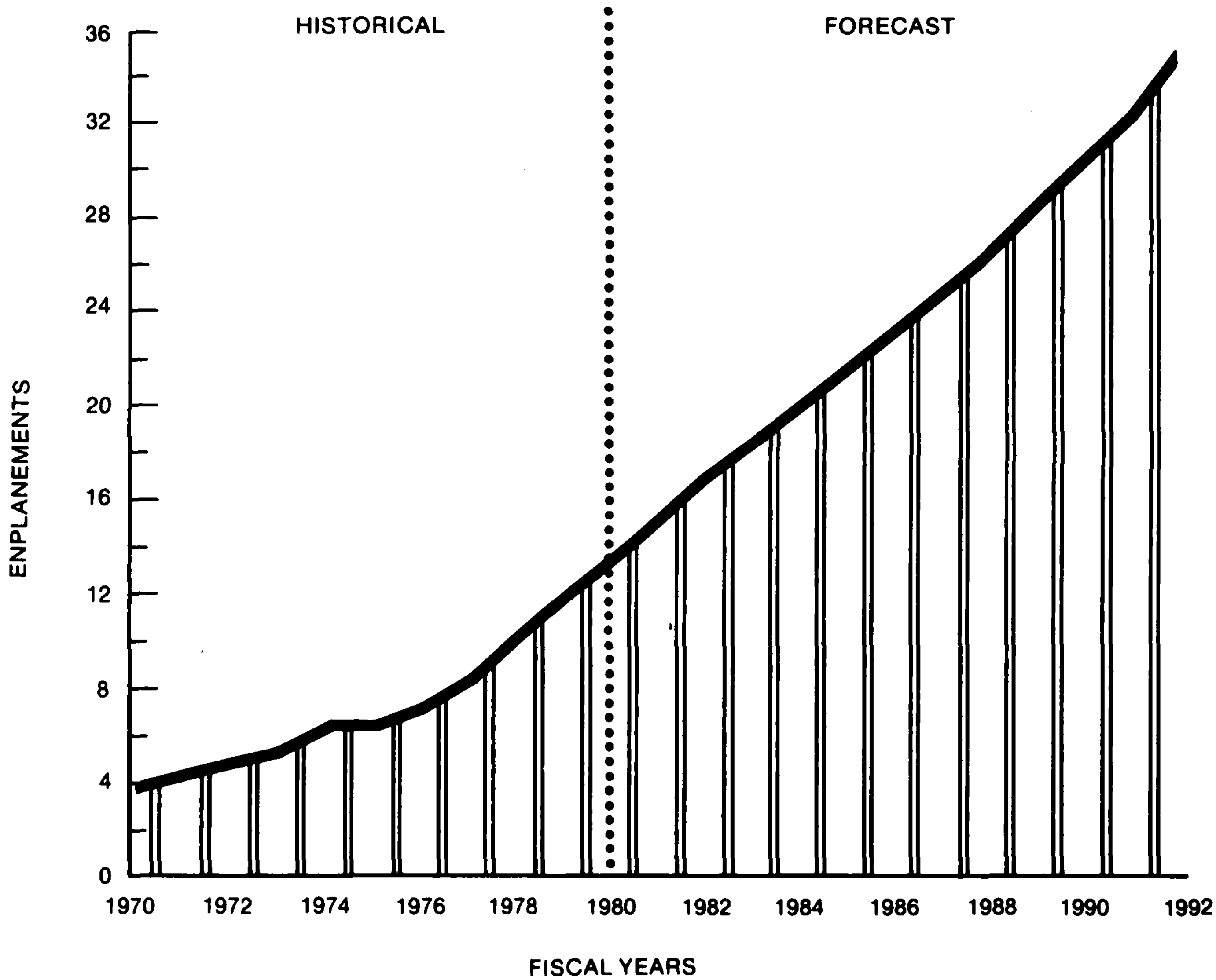
In 1980, the commuter carriers will carry 13.8 million passengers, or 4.5 percent of all fare paying passengers in scheduled air service. By 1992, these carriers are expected to carry 35 million passengers and account for 6.8 percent of all passenger enplanements as shown in Figure II-9.

Nationally, commuter aircraft operations are expected to more than double the 1980 estimated volume of 4.4 million operations by 1992. As air carriers restructure their routes, commuter airlines will continue to move into available markets in smaller cities, and they will perform more operations with smaller aircraft than those used by the trunk and local service airlines. In addition, they are expected to develop new markets as they have done in the past.

The Deregulation Act, for the first time, included the commuters in the Aircraft Loan Guarantee Program administered by the FAA. Aircraft purchases by these relatively small carriers along with opportunities created by the Act have led to a major expansion in the service provided by the commuters. The expansion is expected to continue through the 1980 recession. Future growth will moderate somewhat as this segment develops a mature route structure. Thus, while the number of revenue passengers increased 20 percent in 1979 over 1978 to 12.1 million, the average annual growth rate between 1980 and 1992 is expected to be 8.1 percent.

FIGURE II-9

COMMUTER ENPLANEMENTS
(MILLIONS)



SOURCE: CIVIL AERONAUTICS BOARD

Business use of general aviation is reflected in the changing character of the fleet. The total fleet (80.8 percent single engine piston aircraft in 1979) will grow by 59 percent from 1979 to 1992. At the same time, the more expensive and sophisticated turbine powered part of the fixed wing fleet will grow almost two and one half times that fast, by 143 percent. Turbine powered aircraft represented 2.8 percent of the fleet in 1979. By 1992 the percentage will increase to 4.3 percent. Figures II-10, 11 and 12 illustrate the past trends and forecasted growth in aviation activity and passenger enplanements.

b. FAA Workload. Demand for FAA operational services is anticipated to increase as a result of the growth in aviation activity. Total aircraft operations at FAA towered airports are forecast to increase to 98.4 million in 1992, a 3.1 percent annual growth rate above the 68.6 million operations estimated for 1980. Local operations, primarily for training purposes, are expected to account for a steadily declining portion of airport activity.

Greater use of avionics among the commuter airlines and by general aviation will account for most of the growth in instrument operations at FAA towered airports. Instrument operations are expected to increase from the estimated 38.7 million operations in 1980 to 56.6 million in 1992.

The workload at the Air Route Traffic Control Centers is forecast to increase at a 3.2 percent average annual rate between 1980 and 1992. The increased demand will come primarily from the commuters

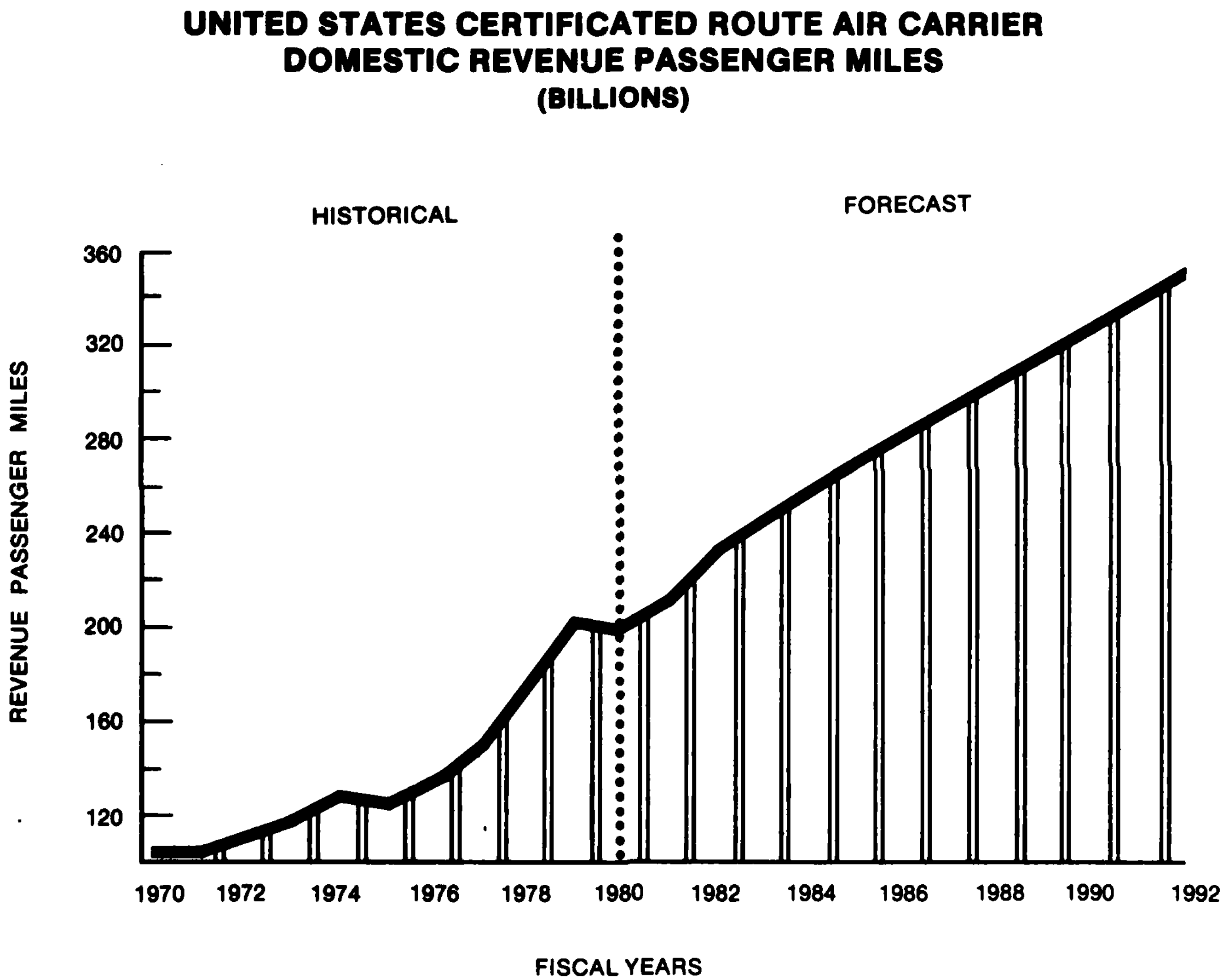
FIGURE II-10

AVIATION ACTIVITY FORECASTS
(FISCAL YEARS)

AVIATION ACTIVITY	HISTORICAL 1975	HISTORICAL 1979	EST. 1980	FORECAST 1981	FORECAST 1982	FORECAST 1992	PERCENT AVG. ANNUAL GROWTH 75/79	79/80	80/81	81/82	80/92
AIR CARRIER, DOMESTIC											
REV. PASS. ENPS. (MILLIONS)	184.9	291.7	290.5	308.9	331.8	481.1	12.1	—0.4	6.3	7.4	4.3
REV. PASS. MILES (BILLIONS)	127.7	205.6	201.9	215.9	232.9	352.7	12.6	—1.8	6.9	7.9	4.8
COMMUTER CARRIERS											
REV. PASS. ENPS. (MILLIONS)	6.6	12.1	13.8	15.5	17.2	35.0	16.4	14.0	12.3	11.0	8.1
REV. PASS. MILES (BILLIONS)	0.7	1.4	1.7	1.9	2.1	4.4	18.9	21.4	11.8	10.5	8.2
GENERAL AVIATION											
FLEET (THOUSANDS)	161.0	198.8	208.0	218.7	228.5	315.5	5.4	4.6	5.1	4.5	3.5
HOURS FLOWN (MILLIONS)	31.9	41.1	42.1	43.9	46.1	64.3	6.5	2.4	4.3	5.0	3.6

SOURCE: CAB, FAA DATA. FAA FORECASTS.

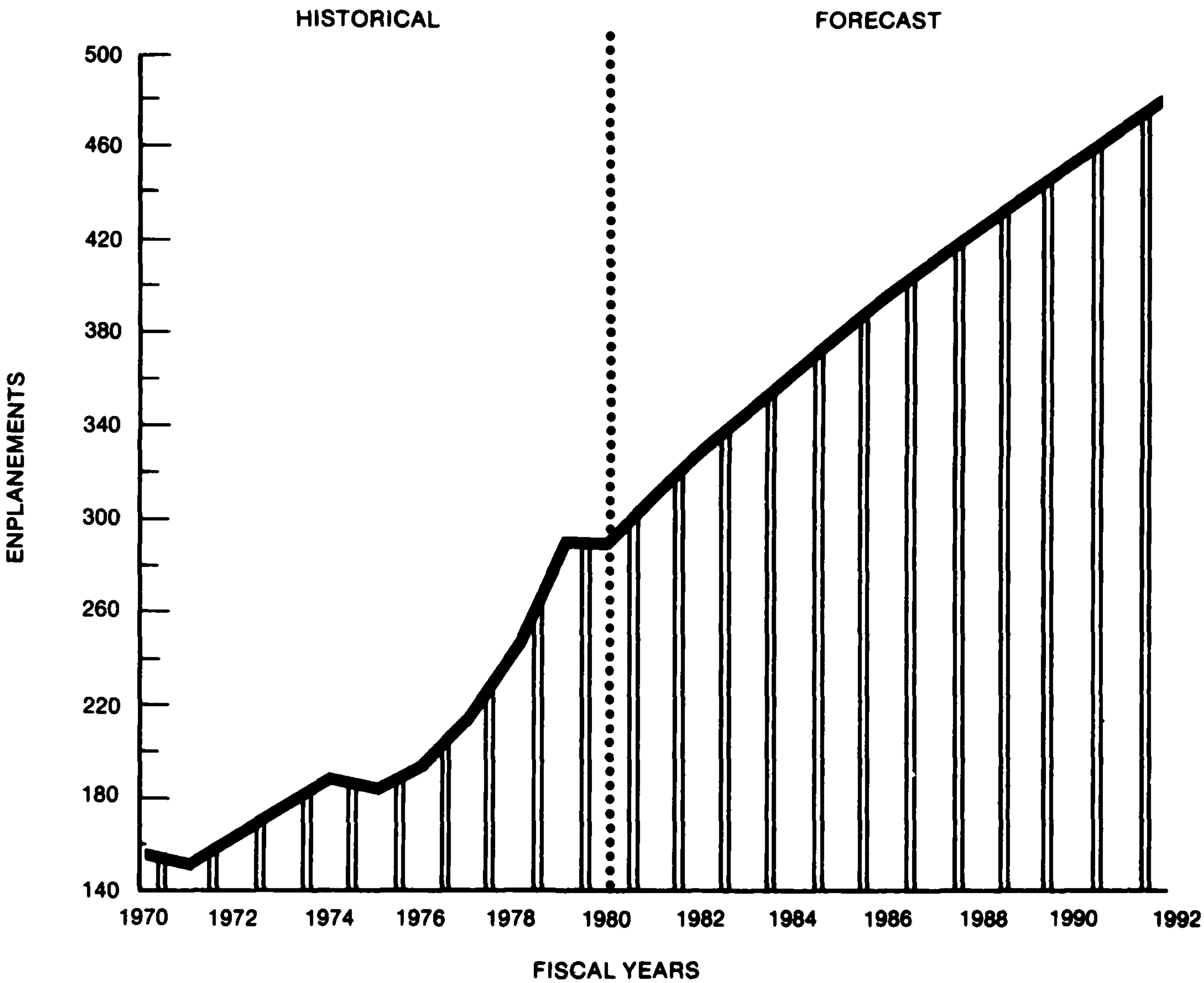
FIGURE II-11



SOURCE: CAB AIR CARRIER TRAFFIC STATISTICS

FIGURE II-12

UNITED STATES CERTIFICATED ROUTE AIR CARRIER DOMESTIC REVENUE PASSENGER ENPLANEMENTS (MILLIONS)



SOURCE: CAB AIR CARRIER TRAFFIC STATISTICS and general aviation. Instrument flight rule departures and arrivals by the commuters are projected to more than double in the next 12 years.

Use of the growing capability of general aviation aircraft joining the fleet now and in the next 12 years is expected to increase the workload at the Flight Service Stations. General aviation business flyers, in particular, are expected to increase their utilization of Flight Service Station assistance to promote safe flying while meeting their schedules. The workload trends are shown in Figure II-13.

In summary, aviation activity is expected to continue to grow significantly faster than the general economy. Aviation will continue to dominate the commercial intercity passenger market. Commuter operations and business use of general aviation are expected to experience greater growth than the larger airlines and personal use of general aviation.

(3) Assumptions In FAA Workload Forecasts. Growth in FAA workload measures is a function of demand imposed on the National Airspace System plus inclusion of activity at locations previously not covered. That is the number of aircraft operations at FAA ATCT equipped airports in 1992 will consist of traffic at the towers existing in 1980 plus the traffic at the additional airports expected to have staffed FAA ATCT's by 1992. Most of the expected growth between now and 1992 will be experienced at the currently staffed FAA ATCT's.

FIGURE II-13

FAA WORKLOAD FORECASTS
(MILLIONS)

	HISTORICAL		EST.	FORECAST			PERCENT AVG. ANNUAL GROWTH				
FAA WORKLOAD MEASURES	1975	1979	1980	1981	1982	1992	75/79	79/80	80/81	81/82	80/92
AIRCRAFT OPERATIONS											
AIR CARRIER	9.4	10.4	10.3	10.5	10.8	12.5	2.6	—1.0	1.9	2.9	1.6
AIR TAXI & COMMUTER	2.7	4.4	4.7	5.0	5.4	9.3	13.0	6.8	6.4	8.0	5.9
GENERAL AVIATION	44.2	51.7	51.1	54.5	57.5	74.1	4.0	—1.2	6.7	5.5	3.1
MILITARY	2.7	2.5	2.5	2.5	2.5	2.5	—1.9	0.0	0.0	0.0	0.0
TOTAL	58.9	69.0	68.6	72.5	76.2	98.4	4.0	—0.6	5.7	5.1	3.1
INSTRUMENT OPERATIONS											
AIR CARRIER	9.5	10.7	10.6	10.8	11.1	12.8	3.0	—0.9	1.9	2.8	1.6
AIR TAXI & COMMUTER	1.9	3.7	4.2	4.4	4.8	9.0	18.1	13.5	4.8	9.1	6.6
GENERAL AVIATION	10.7	17.9	19.6	22.6	23.3	30.5	13.7	9.5	15.3	3.1	3.8
MILITARY	3.9	3.9	4.3	4.3	4.3	4.3	0.0	10.3	0.0	0.0	0.0
TOTAL	26.1	36.2	38.7	42.1	43.5	56.6	8.5	6.9	8.8	3.3	3.2
IFR AIRCRAFT HANDLED											
AIR CARRIER	12.4	14.0	13.9	14.1	14.4	17.0	3.1	—0.7	1.4	2.1	1.7
AIR TAXI & COMMUTER	1.3	2.3	2.5	2.9	3.1	5.6	15.3	8.7	16.0	6.9	7.0
GENERAL AVIATION	5.5	8.8	9.0	9.7	10.2	16.7	12.5	2.3	7.8	5.2	5.3
MILITARY	4.4	4.8	4.7	4.7	4.7	4.7	2.2	—2.1	0.0	0.0	0.0
TOTAL	23.6	29.9	30.1	31.4	32.4	44.0	6.1	0.7	4.3	3.2	3.2
FLIGHT SERVICES											
PILOT BRIEFS	16.2	18.7	18.3	19.2	20.2	30.2	3.7	—2.1	4.9	5.2	4.3
FLIGHT PLANS ORIGINATED	8.0	9.5	9.5	10.0	11.0	16.5	4.4	0.0	5.3	10.0	4.7
AIRCRAFT CONTACTED	10.0	10.2	9.8	9.9	10.0	10.0	0.5	—3.9	1.0	1.0	0.2
TOTAL	58.3	66.6	65.4	68.3	72.4	103.4	3.4	—1.8	4.4	6.0	3.9

SOURCE: FAA DATA. FAA FORECASTS.

It is anticipated that because of increasing air traffic density at airports with FAA traffic control service, the number of Terminal Control Areas (TCA's) and Terminal Radar Service Areas (TRSA's) will increase during the 1980-1992 forecast period. The establishment of a TCA at an airport may have the effect of reducing existing visual flight rule traffic and increasing instrument operations. Since use of terminal radar service in TRSA's is optional, the change in FAA workload is not as great. However, it is believed that the increased safety provided will induce more aircraft operators to avail themselves of the service.

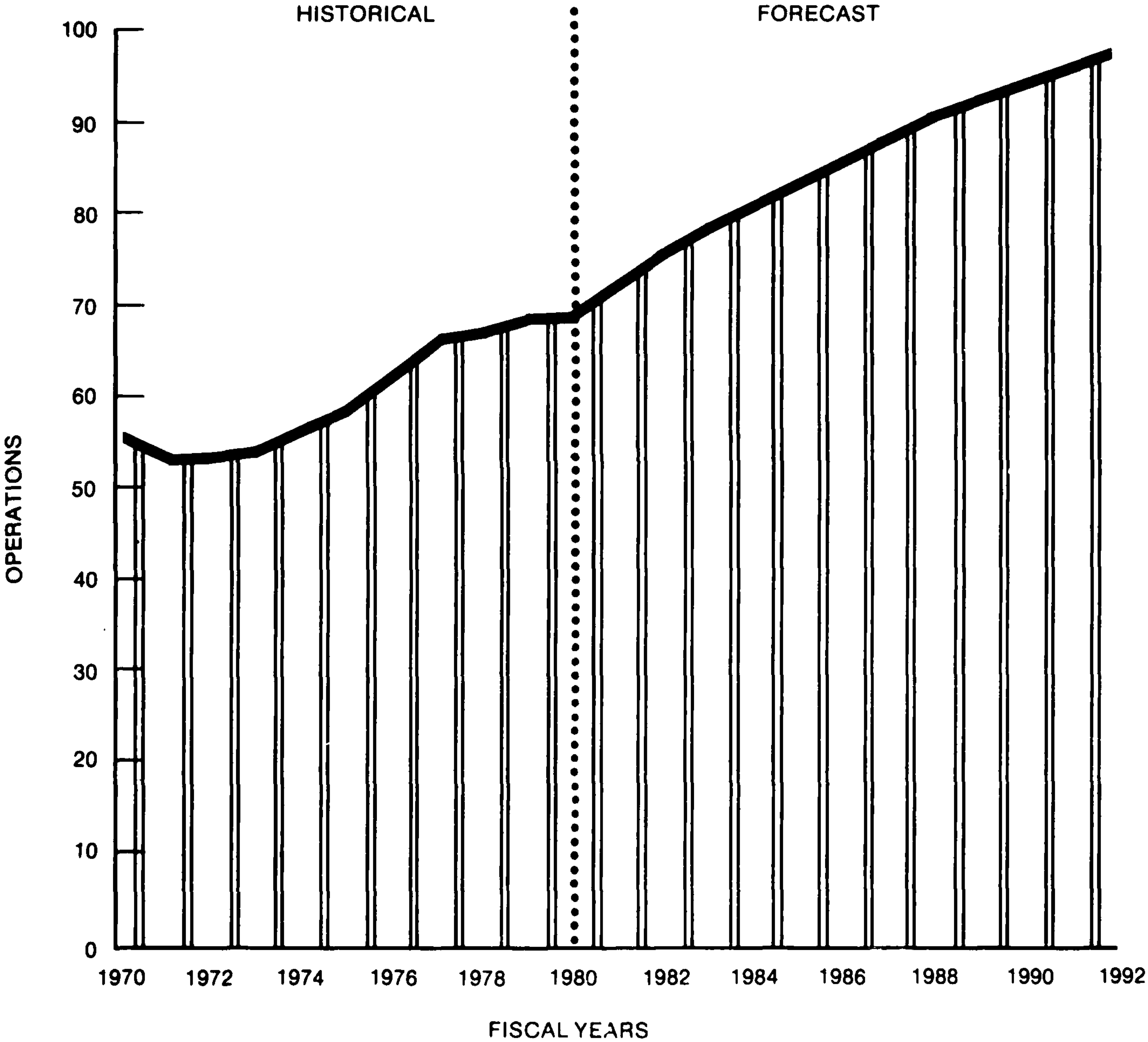
No specific assumptions beyond the changing traffic mix discussed as part of the aviation activity forecasts have been made in developing the air route traffic control center forecast.

There are more than 300 FAA operated flight service stations. A program to consolidate and automate flight services is now underway. The greater convenience of these planned automated facilities is likely to induce greater utilization. However, this increase in demand has not been factored into these forecasts.

(4) Forecast. Aircraft operations at FAA ATCT equipped airports shown in Figure II-14 are expected to increase at a 3.1 percent average annual rate from 68.6 million in 1980 to 98.4 million in 1992. During the first two years of the forecast period (1980-1982), it is anticipated that the annual rate will average 5.4 percent as aviation recovers from the recession. The mix of traffic is likely to become increasingly more

FIGURE II-14

TOTAL OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE (MILLIONS)



SOURCE: FAA AIR TRAFFIC ACTIVITY

heterogeneous since the general aviation and commuter fleets of smaller aircraft are growing at a faster rate than the air carrier fleet of larger jets. Instrument operations at and near airports with FAA towers are forecast to increase about 46.3 percent from 1979 to 1992.

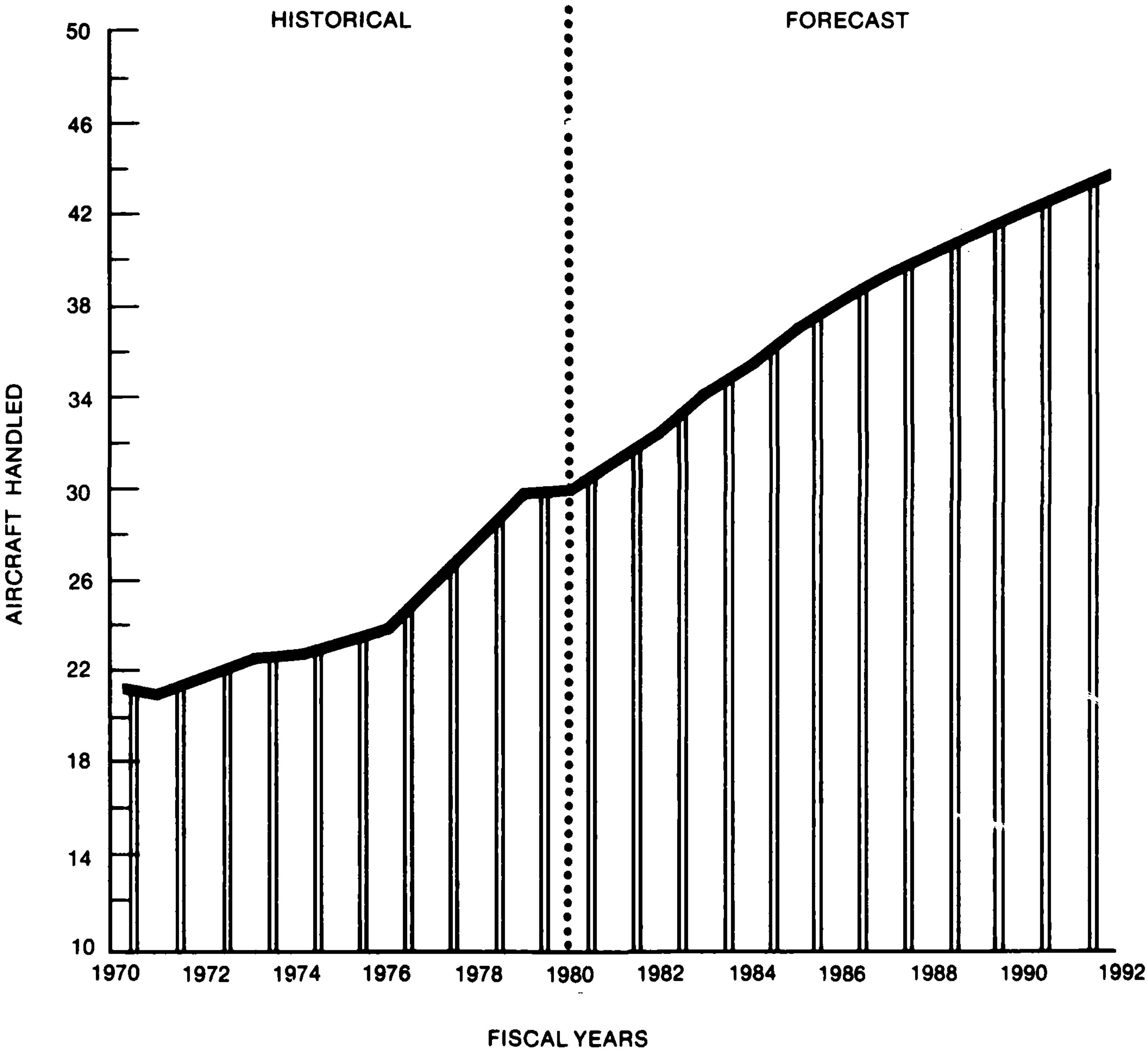
The growth in workload at the air route traffic control centers during the same period is estimated at 46.2 percent. Approximately 46 percent of the traffic now handled at the centers are air carrier flights. By 1992, only 38.6 percent of the centers' workload is expected to be generated by the air carriers. The growth trend at both the towers and centers is shown in Figure II-15.

The forecast for the flight service station calls for a 58.1 percent increase in total services rendered between 1980 and 1992. In the short term from 1980 to 1982, it is anticipated the growth rate will average 5.2 percent per year and slow down to an overall average of 3.9 percent per year for the entire 1980-1992 forecast period.

F. <u>FUTURE SYSTEM DESCRIPTION IN 1986 AND 1991.</u> The Air Traffic Control (ATC) System of the future must consider the system performance problems addressed in Section D in order to maintain and eventually improve the current level of operational safety and efficiency. This section describes in broad terms the changes the ATC system will undergo over the five years, 1982-1986. This in turn is followed by a discussion of changes expected in the succeeding five-year period, 1987-1991. It should be noted that system performance during these two periods is based

FIGURE II-15

IFR AIRCRAFT HANDLED
(MILLIONS)



SOURCE: FAA AIR TRAFFIC ACTIVITY

on proposed funding levels and not on actual implementation of programs. A more detailed explanation of specific programs is contained in Chapter IV.

(1) 1982-1986. The 1982-1986 period is expected to produce improvements which will address both safety and efficiency. A significant safety program during this time frame is the active Beacon Collision Avoidance System (BCAS). Active BCAS equipped aircraft will be capable of determining the proximity of any aircraft equipped with a transponder and for threat aircraft equipped with altitude encoding transponders to determine whether a collision threat is possible and alert the pilot of maneuvers necessary to avoid collisions. In addition, BCAS enhances the present conflict alert signaling which is a ground based (controller) system.

Efforts in metering and spacing of aircraft in the en route environment and improved/automated weather observation, reporting, and dissemination will result in increased efficiency. Substantial energy savings will be realized by holding departing aircraft on the ground and allowing for increased fuel efficiency in flight.

Major terminal system improvements include replacement of the flight data entry and printout equipment (FDEP) with the Flight Data Input/Output (FDIO) System. The FDIO equipment will utilize displays as well as printers, operate with a faster data rate capability and relieve the present saturation problem related to remote devices.

An improved airport surface detection radar system (ASDE-3) will be installed at some high density airports allowing improved ground control of aircraft in virtually any kind of weather, thereby reducing the number of ground conflicts and providing more efficient utilization of runway/taxiway configurations. An improved solid state communication switching system (VSCS) will be installed providing more efficient operations and less intense maintenance requirements.

The implementation of airborne windshear detection and avoidance equipment can have a significant safety improvement. Safety and efficiency improvement will also be achieved from the installation of precision landing systems at airports served by commuter airlines.

The flight service station modernization program will be implemented and will provide more complete pilot access to weather and flight planning information through direct communications between the pilot and the FSS computer.

(2) 1987-1991. Major system changes will begin to evolve in the 1987-1991 time frame. Of specific importance is the replacement of the present en route and terminal data processing systems and the continued implementation of the Discrete Address Beacon System (DABS). The computer replacement program is required to meet forecasted demand and allow for future functional expansion. The DABS system implementation will be the cornerstone of future ATC automation by providing improved secondary surveillance capabilities and the basic data link capability to enable ground-air-ground communications via a digital data link in

addition to voice communications. An additional safety feature possible with the DABS is the automatic Air Traffic Advisory and Resolution System (ATARS). ATARS is a ground based (resident in the DABS computer) conflict alerting system that will automatically alert the pilot of potentially dangerous encroachments by other aircraft into his protected airspace and provide advisories as to maneuvers for resolving potential conflicts.

The terminal enhancements for this time frame include the Terminal Information Display System (TIDS), which will consolidate all data presently required by a tower controller in a more efficient and productive manner, and additional capabilities added to lower activity automated terminals (ARTS II) such as radar tracking and Minimum Safe Altitude Warning (MSAW). Microwave landing systems will begin to be deployed providing more fuel efficient and variable landing approach paths to airports. The MLS will be especially beneficial to reliever airports where terrain would not allow implementation of an instrument landing system. New solid state terminal radars (ASR-9) with moving target detection (MTD) and remote maintenance monitoring (RMM) will replace existing ASR-4, 5 and 6 tube type radars.

CHAPTER III: NATIONAL AVIATION SYSTEM NEEDS

A. OVERVIEW. The needs of the National Airspace System in terms of additional air traffic control, navigation, and airport facilities are anticipated to increase significantly as aviation growth continues into the foreseeable future. How these needs are satisfied for different levels of system performance resulting from varying levels of capital investment is the main thrust of this chapter.

B. RECENT TRENDS.

(1) Cross-Modal Comparisons. Aviation comprises only one of several areas of capital spending within the Department of Transportation. To provide a perspective on the Federal share of capital investment funds appropriated to the FAA, 1/ that share has been compared to the trends of other DOT Administrations. DOT Administrative accounts included in this capital expenditure comparison are as follows:

Administration	Account
Coast Guard	. Acquisition, Construction & Improvements
	. Alteration of Bridges
FHA	. Federal-Aid Highways
FRA	. Northeast Corridor Improvements Program
	. Grants to the National Railroad Passenger Corporation (AMTRAK) - Capital Grants and Loan Guarantees.
UMTA	. UMTA Fund (capital investment activities)

1/ The FAA capital expenditure account includes only the appropriations for Facilities and Equipment.

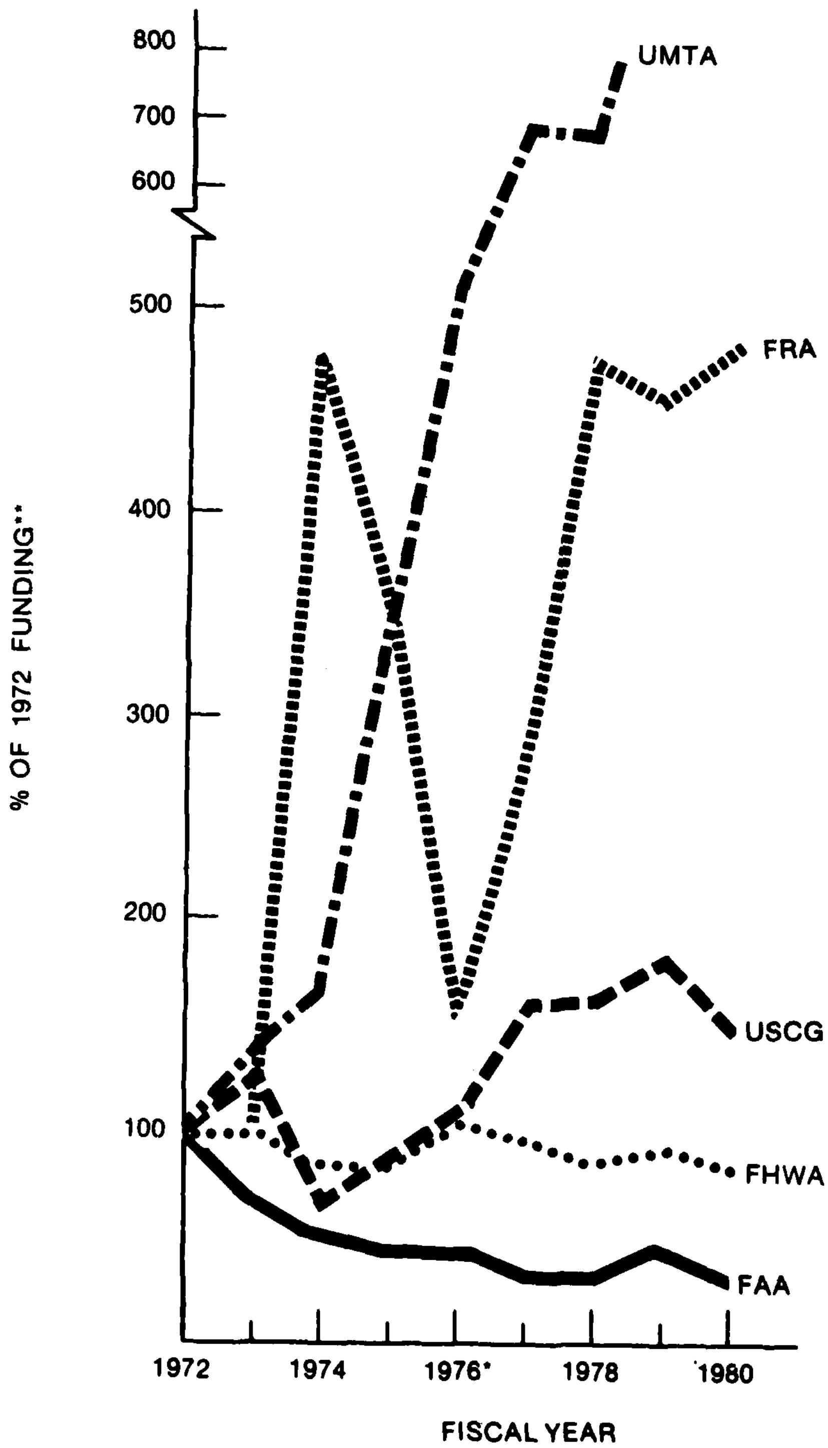
The capital investment, as used here for all the DOT Administrations, includes programs that yield future benefits through construction, acquisition or alteration of physical assets.

An index indicating change in constant dollars of the FAA capital expenditure Facilities and Equipment appropriations as compared to the other DOT modes is shown in Figure III-1. Although these appropriations cannot be taken as complete and absolute measures of capital investment, they are nevertheless indicators of the general trend in the Federal share of major capital investment activity over the last decade. The inability to account precisely for capital investment activity arises because capital budgets are not identified specifically as "capital or investment-type programs" financed separately from "current or operating-type programs;" rather, DOT budgets are typically program-oriented. However, the comparison illustrates the relative long-term trend in the Federal share of capital investment in transportation and dramatically shows that FAA has consistently done most poorly in receiving capital expense appropriations when compared to the other DOT Administrations.

In the area of research appropriations, FAA has remained relatively stable when measured in current year dollars. However, the buying power of those dollars has shown a steady decline (Figure III-2). In FY-1981, for example, FAA will be able to accomplish only about one-half of the research effort that it did in FY-1972. FAA has again consistently done most poorly when compared with the remaining DOT Administrations. Adding to this concern is the fact that NASA has been

FIGURE III-1

INDEX OF APPROPRIATIONS TO MAJOR DOT CAPITAL INVESTMENT ACCOUNTS CONSTANT DOLLARS (FAA = F&E ONLY)

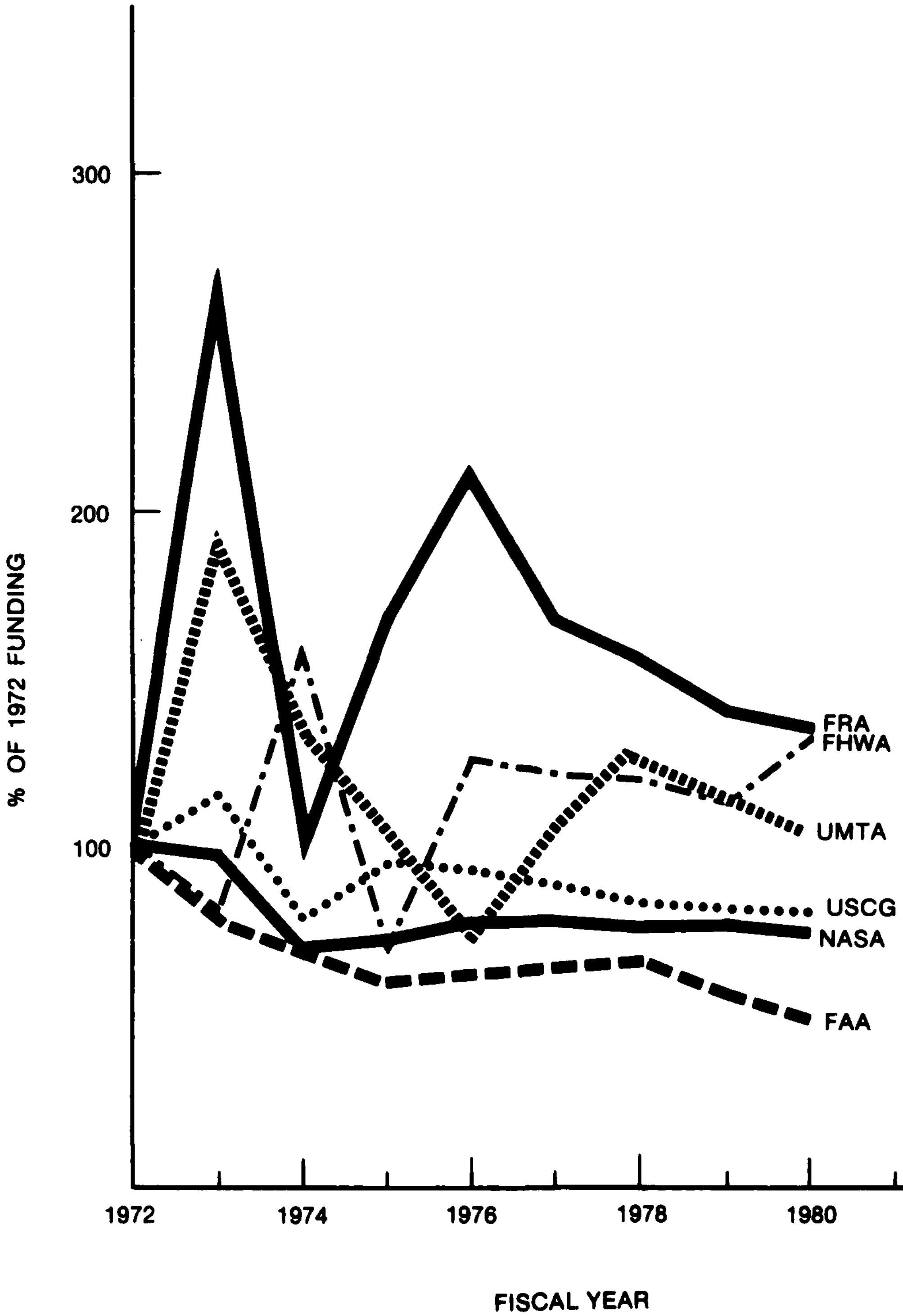


* FY 76 AND TQ ANNUALIZED.

**EXCEPT FRA (1973 FUNDING)

FIGURE III-2

INDEX OF APPROPRIATIONS* TO MAJOR DOT RESEARCH & DEVELOPMENT ACCOUNTS
(CONSTANT DOLLARS)



*FHWA: PROGRAM COSTS
UMTA: CAPITAL OUTLAYS

the second worst ten-year performer. This means that Federal investments in civil aviation related research (FAA and NASA) have been seriously eroded in both absolute terms and in comparison to other transportation modes.

(2) Levels of Funding.

a. Airport Grants-In-Aid Program. The current status of the Airport Grants-In-Aid Program reflects actions that were taken in the late 1960's. At that time, airport congestion was an extremely serious problem that was expected to worsen rapidly as air traffic increased. Relatively few major improvements had been made to the civil airport system since the end of World War II, when many military facilities had been converted to civil use. A major investment was needed to increase the capacity of busy air carrier airports, upgrade airports to serve jet aircraft, and provide new and improved general aviation airports. The ability of the aviation community to finance development on this scale was severely limited, because only the busiest airports generated enough revenues to be self-supporting. There had been the modest Federal Aid Airport Program (FAAP), funded out of general revenues, but it never exceeded $75 million annually, and this was too little to finance effectively the development that was needed.

After lengthy deliberation, a trust fund was established by the Congress in 1970 to provide some of the necessary financing. The fund received revenues from a variety of user taxes and fees, the most significant of which was an eight percent tax on domestic passenger airline tickets. A portion of the trust fund was appropriated by Congress for the Airport Development Aid Program (ADAP). Under this program, Federal aid was increased to $640 million a year in 1980, when the enabling legislation expired. Figure III-3 illustrates this past funding trend. In constant dollar terms, however, it is worth noting that the 1980 level was only slightly higher than that of 1972. This too is depicted in Figure III-3.

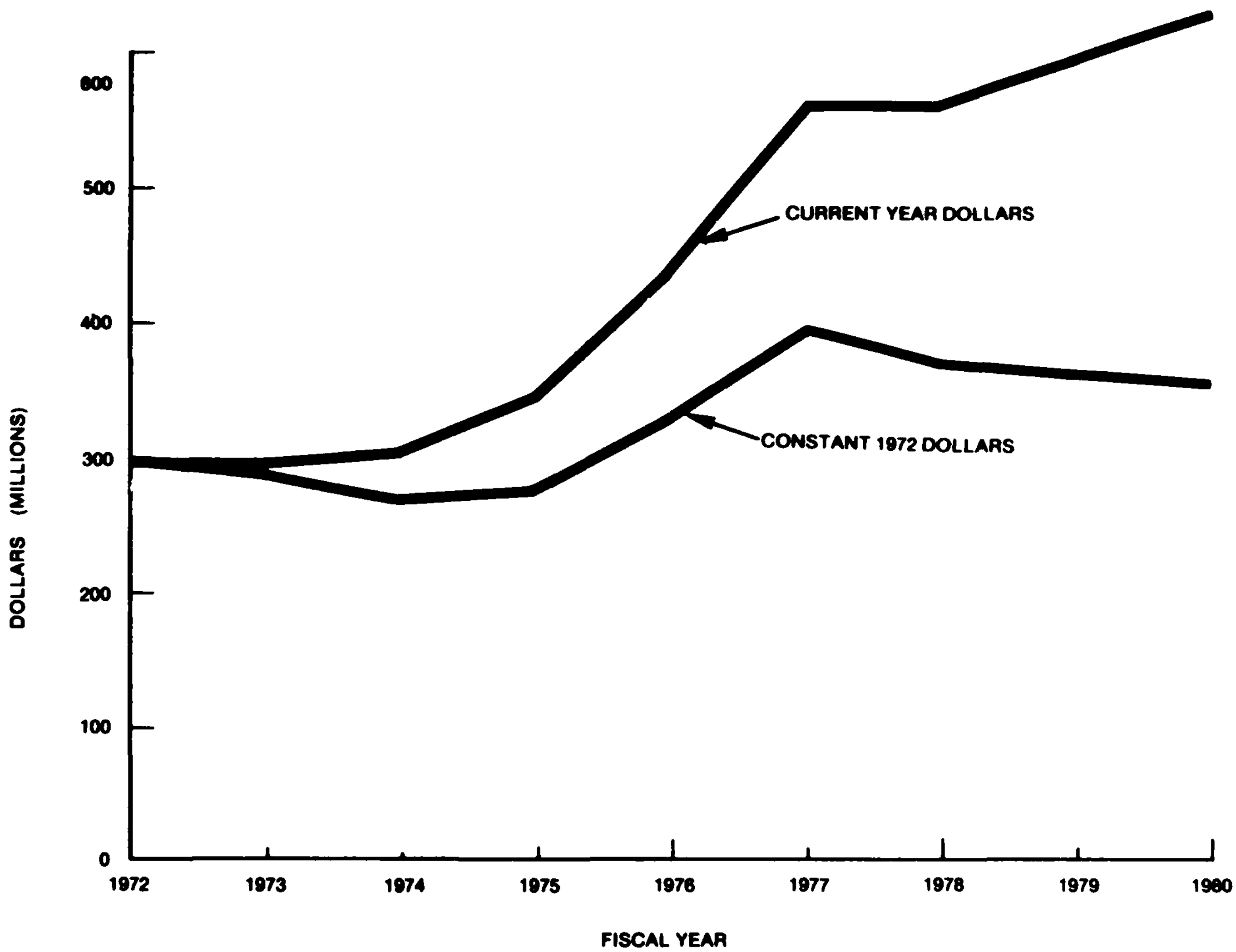
b. Facilities and Equipment. The Facilities and Equipment (F&E) appropriation finances the FAA's capital investment program for air traffic control and air navigation facilities, experimental facilities, and aircraft used in facility flight inspection.

F&E programs have been approved for specific work projects such as Airport Traffic Control Towers and Airport Surveillance Radars on a year-by-year basis. Assumptions adopted for past F&E Appropriation funded activities are as follows:

- Capital investment needs vary and should be met on a year-to-year basis for system modernization, system expansion and implementation of desirable developmental products.
- System modernization and replacement are accomplished in a phased manner to ensure a high quality NAS which is not overloaded with old, outmoded equipment and facilities, and which incorporates current technological, operational and procedural efficiencies.
- Products to improve the system which result from the agency's development activities are implemented as they become available.

FIGURE III-3

AIRPORTS GRANTS-IN-AID APPROPRIATIONS



- System expansion takes place continuously as aviation activity increases. Expansion has occurred at a fairly even rate, producing no significant negative impacts on the aviation community.

In the past, the most commonly used F&E level to accomplish these programs has been $250 million per year — which corresponds to the minimum F&E levels specified in the Airport and Airway Development Act of 1970 and Amendments of 1976. The funding levels from 1972 through 1981 are shown in Figure III-4.

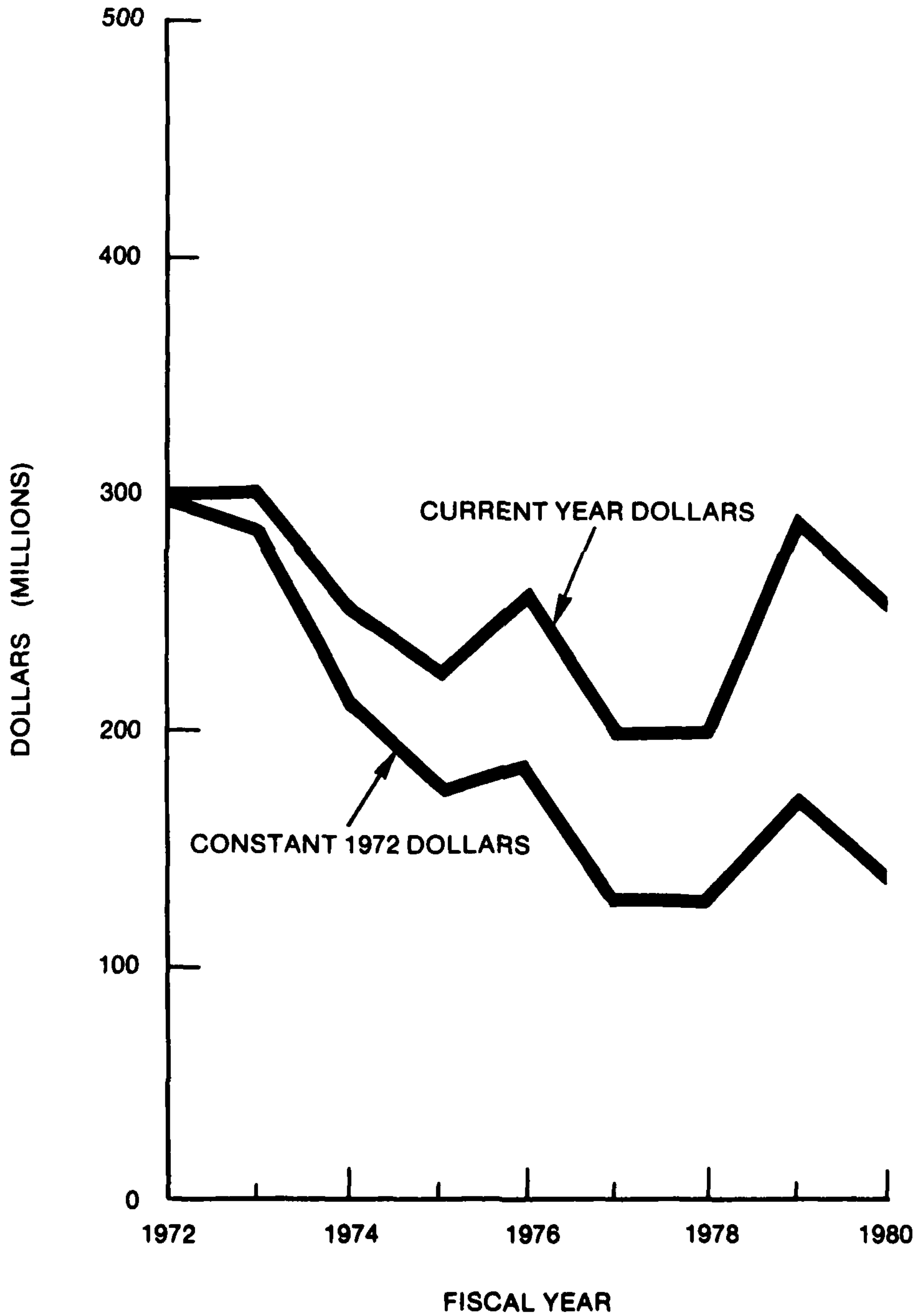
The main emphasis of the R,E&D program during the past ten years has been based upon the engineering and development recommendations from the "Report of Department of Transportation Air Traffic Control Advisory Committee dated December 1969."

The committee's report was used as the basis for the FAA's Major Systems Development program. Highlights of FAA research accomplishments resulting from these recommendations are as follows:

- Enhancements of the existing terminal and en route computing systems to improve the safety and efficiency of the current Air Traffic Control System.
- Development of a new precision approach landing system called Microwave Landing System (MLS) to replace the existing Instrument Landing System (ILS).

FIGURE III-4

FACILITIES & EQUIPMENT APPROPRIATIONS



- Development of the Discrete Address Beacon System (DABS) to improve the quality of ATC surveillance data, and an integral DATA LINK for providing collision avoidance protection to equipped aircraft.

- Development of the aircraft separation program which will provide better protection against mid-air collisions. Program elements include conflict alert, conflict resolution, beacon collision avoidance systems (BCAS), and automatic traffic advisory and resolution service (ATARS) (through DABS).

- Development of a highly efficient automated system of flight services, concentrating on improvements in providing real-time weather information to pilots and controllers and providing more accessible flight service station services through automated self-briefing terminals.

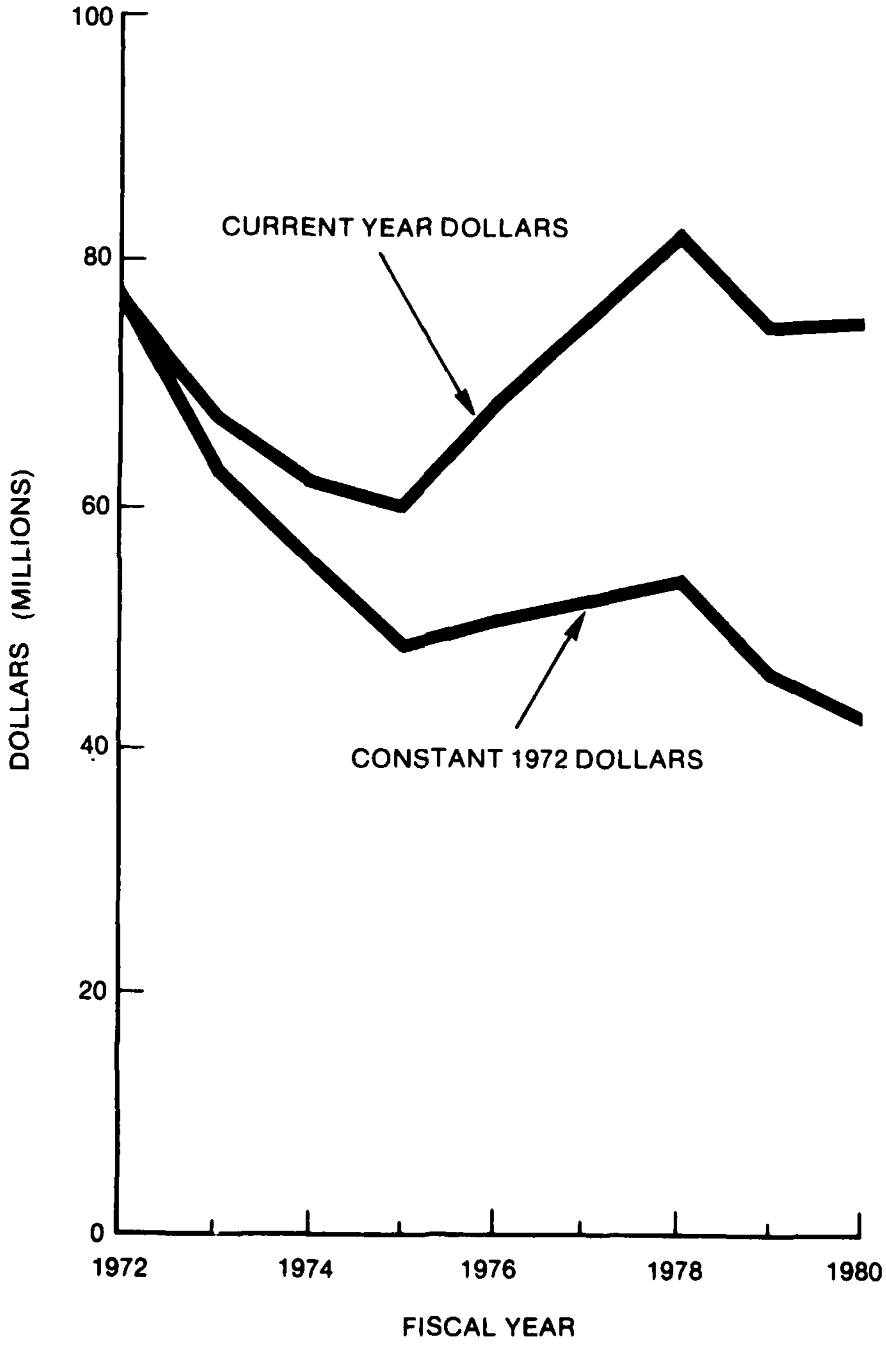
- Development and implementation of a system which have significantly reduced the possibility of Wind Shear related accidents.

- Increased emphasis on Advanced ATC System Development and New Initiatives to ensure that future technologies will be available to meet the ATC needs of the future.

There have also been other significant engineering and development programs completed and new initiatives started during this ten year period. The funding levels for all these programs from 1972 through 1981 are shown in Figure III-5.

FIGURE III-5

RESEARCH, ENGINEERING & DEVELOPMENT APPROPRIATIONS



C. EXPECTED SYSTEM PERFORMANCE.

(1) Prospectus. Achieving acceptable levels of system performance over the next decade will require major aviation capital expenditures. The substantial increases in operations conducted and passengers carried projected over the next decade suggest that investments will be needed not only in the air traffic control system and associated user equipment but also in airports, terminals and access and egress systems. Based on past history, funding for airport improvements will be provided by state and local governments, airport sponsors, system users and the Federal Government while the air traffic control system will be funded through Federal appropriations.

The remainder of this chapter is devoted to an analysis of the Federal share of these expenditures, focusing on Facilities and Equipment (F&E) and Grants-In-Aid for Airports. Improved system performance brought about by projects completed in the Research, Engineering and Development program is reflected through F&E and the Grants-In-Aid for Airports programs.

(2) Facilities and Equipment Capital Investment Alternatives. This section examines the amount of investment necessary to meet anticipated demand at varying levels of system performance. Five alternative investment strategies are defined; funding levels required to achieve each are estimated; and system performance which can be expected to characterize each is projected.

a. Investment Alternatives.

1. Physical Wear Out. The "replace only when physically worn out strategy" could be carried out with very low capital outlays which would include fixed overhead items, replacement of facilities which are totally worn out, and replacement of facilities destroyed by fire or other types of disaster. Specifically excluded are replacements of items which are still functional, even though replacing them with new equipment might be less costly on a lifecycle cost basis. A major characteristic of this policy would be the repairing of all items as long as it is physically possible. In effect, maintenance expenditures would be substituted for capital outlays to the maximum extent possible.

2. Economic Replacement. The "replace when economically obsolete" approach would include making those capital expenditures required under "Physical Wear Out" and in addition, undertaking all cost effective replacement projects. Under such a policy the existing system would be operated in the most efficient (lowest cost) manner possible. Existing equipment would be retained only as long as economically feasible. When a replacement item became less costly on a lifecycle basis than its existing counterpart, the replacement item would be acquired. Accordingly, inefficient maintenance expenditures would be avoided. Although capital expenditures would be higher than under "Physical Wear Out," overall costs would be lower. The difference in overall costs is the productivity payoff achieved by opting for "Economic Replacement" rather than "Physical Wear Out."

3. <u>Expansion -- Existing Technology.</u> The investment policies of this alternative seek to meet growing system demand while holding the level of service quality approximately constant. Included are all capital outlays under "Economic Replacement" plus cost-beneficial upgradings and new establishments. Specifically excluded are all systems not yet ready for acquisition because they require additional research, development and testing or which rely on new technology. Accordingly, this alternative might be dubbed "more of the same." Examples of expenditures under such a policy include establishment of new Instrument Landing Systems and Airport Traffic Control Towers. Programs not included would be the Discrete Address Beacon System and the Microwave Landing System.

4. <u>Expansion -- New Technology.</u> This investment alternative also seeks to satisfy growing demand. It includes all outlays found in "Economic Replacement" and "Expansion—Existing System." In addition, it includes additional projects which utilize new technologies targeted at improving system capacity at critical locations as well as improving system safety. Typical new technologies included are the Discrete Address Beacon System, and the Microwave Landing System.

5. <u>Quality Improvement.</u> This alternative consists primarily of safety oriented projects which employ new technology. A basic characteristic of these projects is that they are independent of other investments and can be undertaken currently or at some future time. Accordingly, this alternative does not incorporate the projects of the other alternatives; rather, it can be annexed to any of the others.

Examples of programs classified under this alternative are the Low Level Wind Shear Detection System, Frangible Approach Light Towers, and Doppler Weather Radar.

b. Evaluation. In this section funding levels required for each investment alternative for the 1982 through 1986 and 1987 through 1991 periods are estimated. Benefits of each investment alternative are evaluated in terms of the three major parameters of system performance: safety, capacity and productivity. Because each alternative except "Quality Improvement" includes all previous alternatives, each estimate of benefits or costs is a cumulative value. However, given its independence of the other alternatives, "Quality Improvement" values include only incremental amounts. Unless otherwise indicated, all values are expressed in 1980 constant dollars.

The costs for each of the investment alternatives for 1982 through 1986 and 1987 through 1991 periods are assumed to occur during these periods. However, the benefits from these investments occur beginning in 1984 and extend for 15 years from the year of investment. In this analysis though only the benefits from the 1982 through 1991 period are shown. For this reason and also because no discounting has been done, the costs and benefits cannot be compared as a benefit/cost ratio. Instead, benefits should be taken as an indication of the comparative merit of each investment alternative.

Investment cost estimates are made by identifying those F&E projects which are specific to each of the alternatives. Combining the projected costs for all programs identified with each alternative yields the cost estimates.

Benefits associated with each alternative are basically related to F&E cost estimates of programs listed in Appendix I. For many agency programs, this is accomplished on the basis of known benefit-cost relationships, which have been independently estimated. For other programs, benefits are assumed to equal costs. In many cases where this assumption is made, the size of the program is relatively small or benefit-cost analysis is currently under development. In other cases, the agency has indicated that a valid requirement is tantamount to a judgmental estimate that benefits of a program are equal to or greater than its cost. This procedure will tend to understate benefits. On the other hand, it must also be realized that when a large program for which a requirement has yet to be validated is assumed to have benefits equal to costs, the benefit estimates may be overstated to the extent that benefits fall below costs. Such a situation may exist for several programs. The presence of this analytical difficulty will be indicated where possibly significant.

In addition to dollar estimates of benefits, the potential number of lives saved and hours of delay avoided under each alternative are reported in Figure III-6. The values in the table are increments associated with each investment alternative over the next lower one. Because each alternative except "Quality Improvement" presupposes the undertaking of all previous alternatives, the total avoided delays and fatalities are cumulative. These values are shown in parentheses.

FIGURE III-6
Avoided Fatalities and Delays

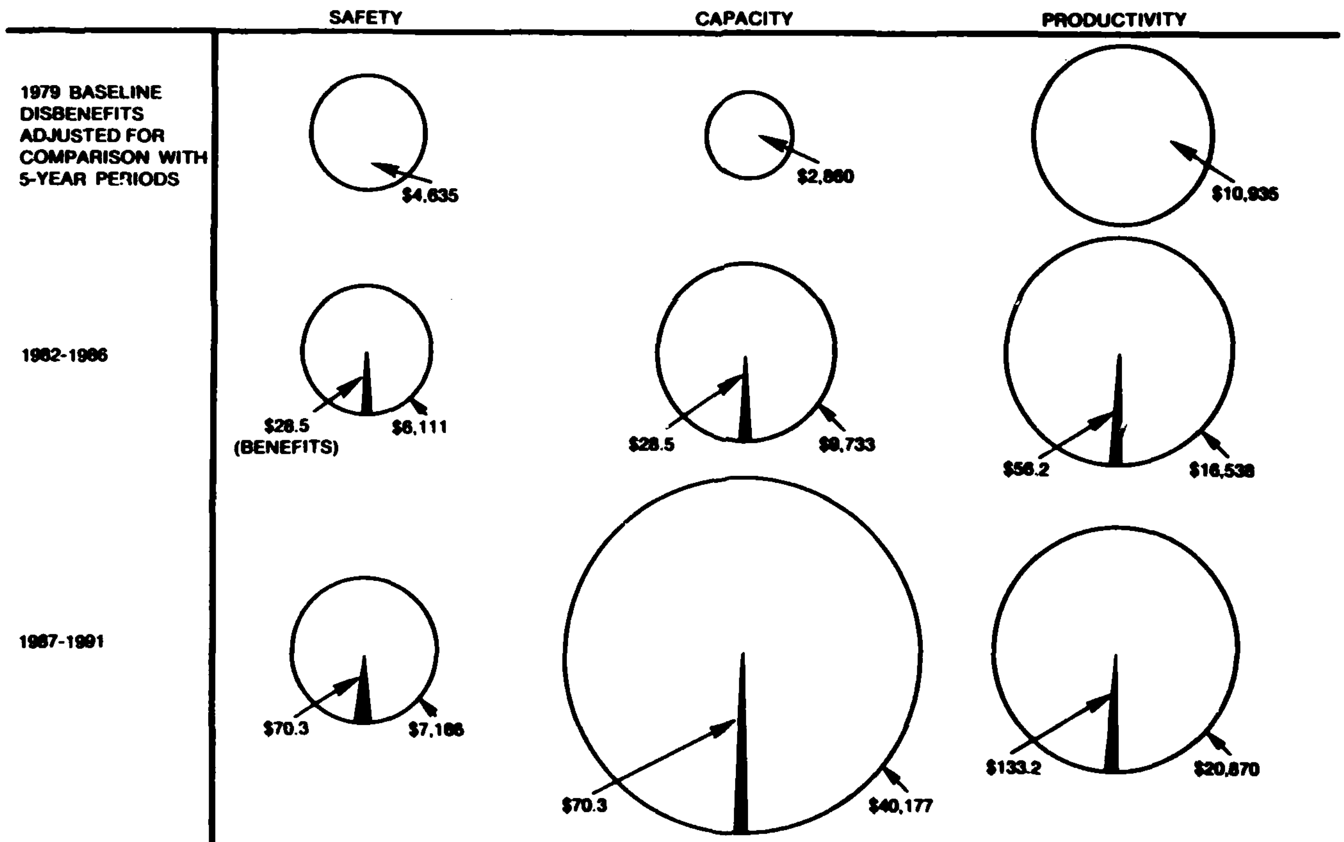
Period	Alternatives					
	Physical Wear Out	Economic Replacement	Expansion Existing Technology	Expansion New Technology	Quality Improvement	Total
82-86						
Fatalities Avoided	61	184 (245)	578 (823)	251 (1074)	299	1373
Delay Avoided (Thousands of Hours)	14	7 (21)	218 (239)	125 (364)	54	418
87-91						
Fatalities Avoided	150	400 (550)	1063 (1613)	814 (2427)	443	2870
Delay Avoided (Thousands of Hours)	34	30 (64)	385 (449)	406 (855)	91	946

Source: APO-100
Cumulative Values in Parentheses

1. Physical Wear Out. Adoption of the "Physical Wear Out" alternative would require about $447 million in F&E expenditures through 1991. The system will continue to operate and some potential delays and fatalities will be avoided. System performance measures -- accident, delay and operating costs -- for 1979, 1982-1986, and 1987-1991 are indicated in Figure III-7. Benefits expected from investments for each time period under "Physical Wear Out" are shown by the shaded circle segments. The small benefits associated with this alternative occur because the replacement of totally worn out equipment involves acquisition of new modern equipment and not exact copies of the original.

FIGURE III-7

BENEFITS ACHIEVED FROM REPLACE FACILITIES WHEN COMPLETELY WORN OUT ("PHYSICAL WEAR OUT")



NOTES:

1. IN MILLIONS OF CONSTANT 1980 $'s.
2. THE CIRCLES REPRESENT THE DOLLAR DISBENEFITS ACCRUED IF NO CAPITAL INVESTMENTS ARE MADE FOR EXPANDED, NEW OR MODERNIZED FACILITIES.
3. SHADED AREA IN EACH CIRCLE REPRESENTS THE BENEFITS TO BE ACHIEVED FROM CAPITAL INVESTMENTS.

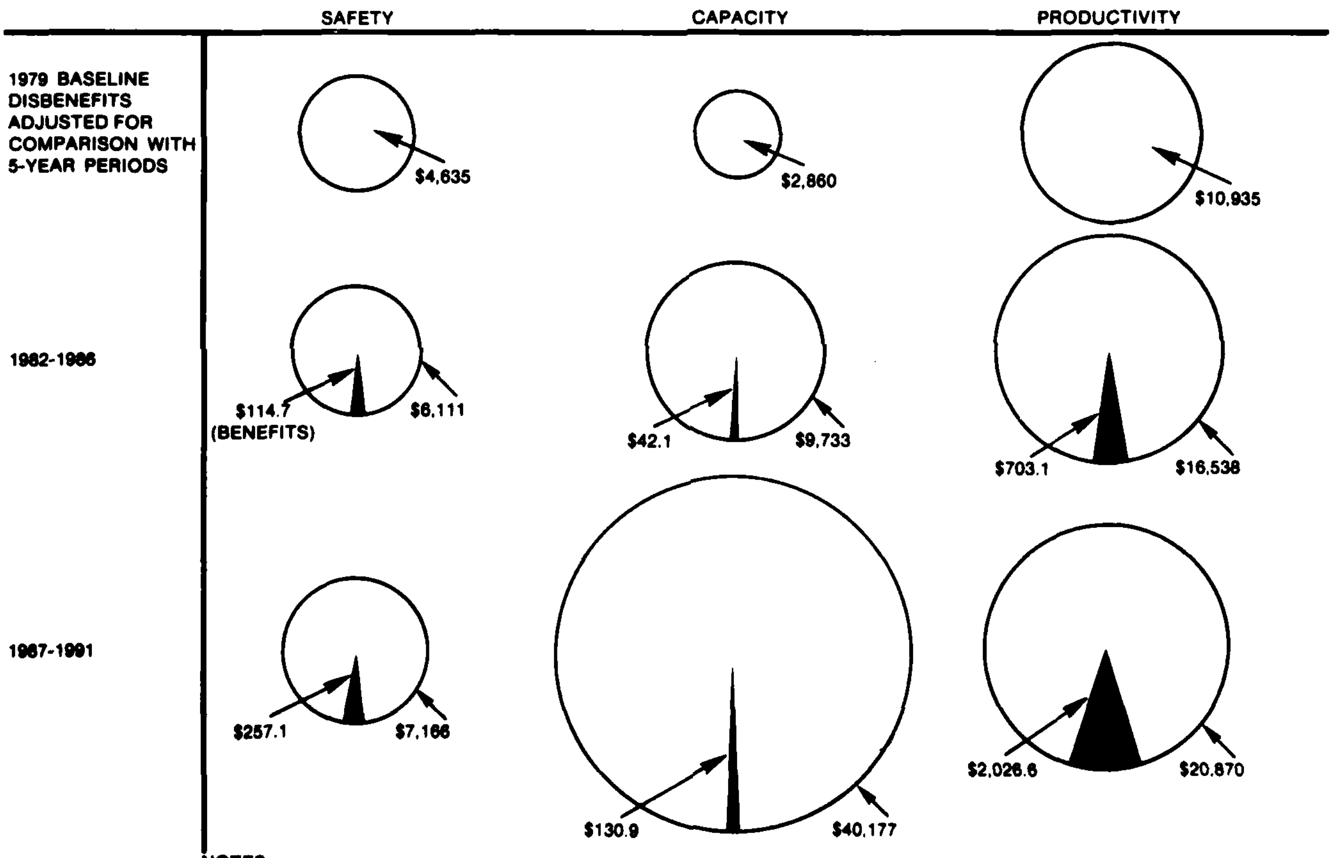
Under this alternative, system performance would rapidly deteriorate. For delays, this will happen for two reasons: (a) much aviation delay involves queuing and increases in an exponential fashion; and (b) as activity increases, attempts will be made to hold prevailing safety rates constant by accepting additional delay. Because delay and safety are substitutable only at ever diminishing rates, more and more delay will be required to maintain initially prevailing levels of safety. It is eventually expected that accident rates themselves will begin to rise resulting in accident costs increasing more rapidly than traffic growth. Operating costs will also begin to increase sharply as FAA equipment and structures become older and older.

The major programs of this alternative are Miscellaneous Replacement and Modernization, and Facilities Flight Inspection. Miscellaneous Replacement and Modernization involves replacing or repairing equipment as necessary to keep the system functioning. Flight Inspection consists of the periodic checking of navigational facilities from the air to insure they are operationally acceptable.

2. Economic Replacement. "Economic Replacement" requires about $1.4 billion in F&E expenditures between 1982 and 1986 and $2.6 billion from 1987 to 1991. This represents annual expenditures of $289 million and $512 million in the first and second periods, respectively. As indicated by Figure III-8, safety and capacity benefits will be moderately above those under "Physical Wear Out." However, productivity benefits will be substantially more. In the 1982 to 1986 period,

FIGURE III-8

BENEFITS ACHIEVED FROM REPLACE FACILITIES WHEN ECONOMICALLY BENEFICIAL
("ECONOMICAL REPLACEMENT")



NOTES:

1. IN MILLIONS OF CONSTANT 1980 $'s.
2. BENEFITS INCLUDE PREVIOUS ALTERNATIVES.
3. THE CIRCLES REPRESENT THE DOLLAR DISBENEFITS ACCRUED IF NO CAPITAL INVESTMENTS ARE MADE FOR EXPANDED, NEW OR MODERNIZED FACILITIES.
4. SHADED AREA IN EACH CIRCLE REPRESENTS THE BENEFITS TO BE ACHIEVED FROM CAPITAL INVESTMENTS.

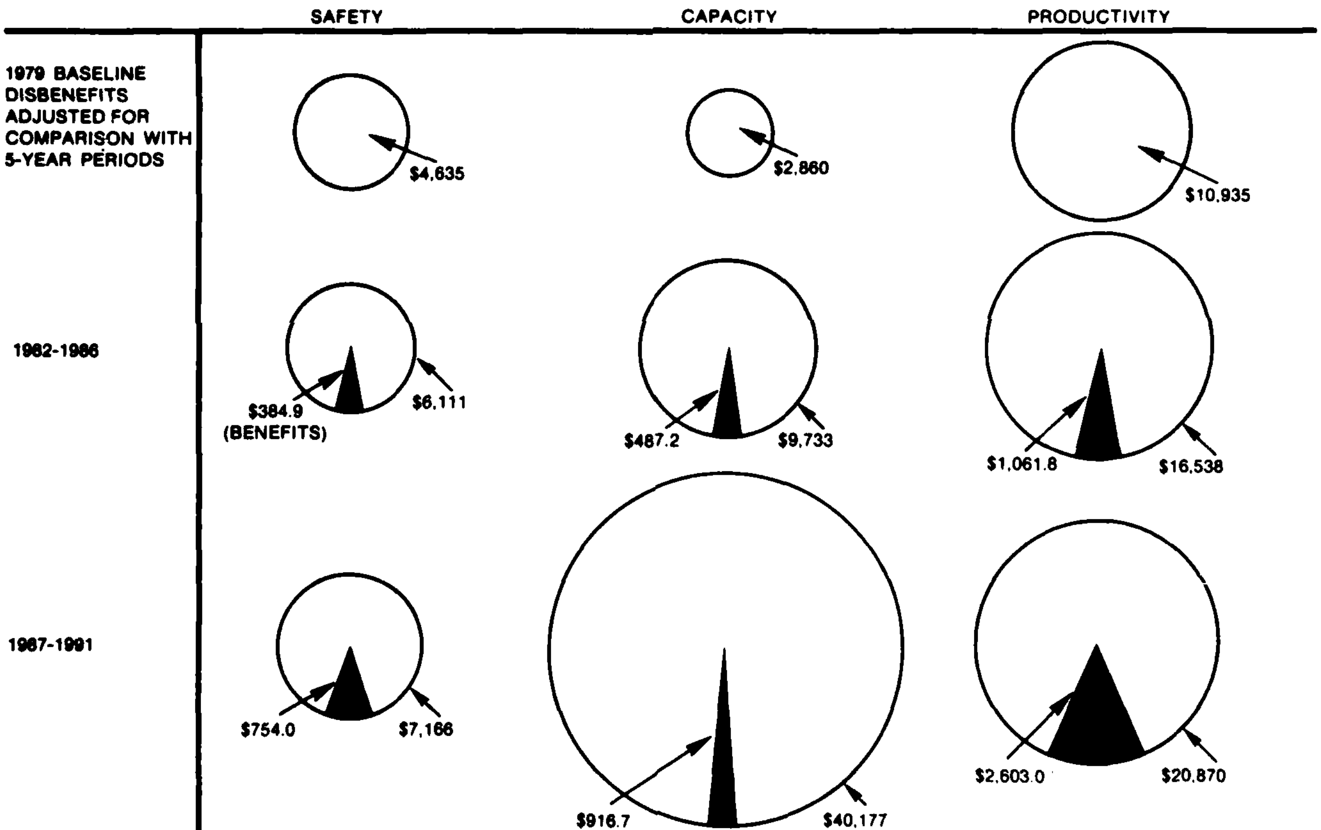
productivity benefits are expected to total about $700 million while in the 1987 to 1991 period, benefits of $2,027 million are projected. Capacity benefits of $42 million and $131 million are expected for the 1982-1986 and 1987-1991 periods, respectively. Estimated safety benefits are $115 million and $257 million for the two respective periods.

3. Expansion -- Existing Technology. This alternative requires funding of about $2.9 billion (1980 dollars) over the 1982-1986 period and $3.7 billion during the 1987-1991 period. This is equivalent to annual outlays of $570 million and $745 million. As shown in Figure III-9, during the respective five year comparison periods safety benefits will be about $385 and $754 million. Capacity benefits will be $487 and $917 million while productivity gains of $1,062 and $2,640 million should be realized. In terms of physical units, about 687 thousand delay hours will be avoided and about 2,436 fatalities prevented over the 1982-1991 period.

4. Expansion -- New Technology. "Expansion -- New Technology" is an attempt to deal with the problems of safety and delay attendant to the growth in air traffic through the addition of new technology systems. It consists of the implementation of such advanced systems as the Discrete Address Beacon System and Automatic Traffic Advisory and Resolution Service. The advanced nature of many of these systems precludes accurate assessment of their benefits at this time, although further evaluation continues. This analysis makes the assumption that programs will actually be undertaken only if additional evaluation indicates benefits to equal or exceed costs. Accordingly,

FIGURE III-9

BENEFITS ACHIEVED FROM EXPAND SYSTEM USING EXISTING TECHNOLOGY ("EXPANSION - EXISTING TECHNOLOGY")



NOTES:

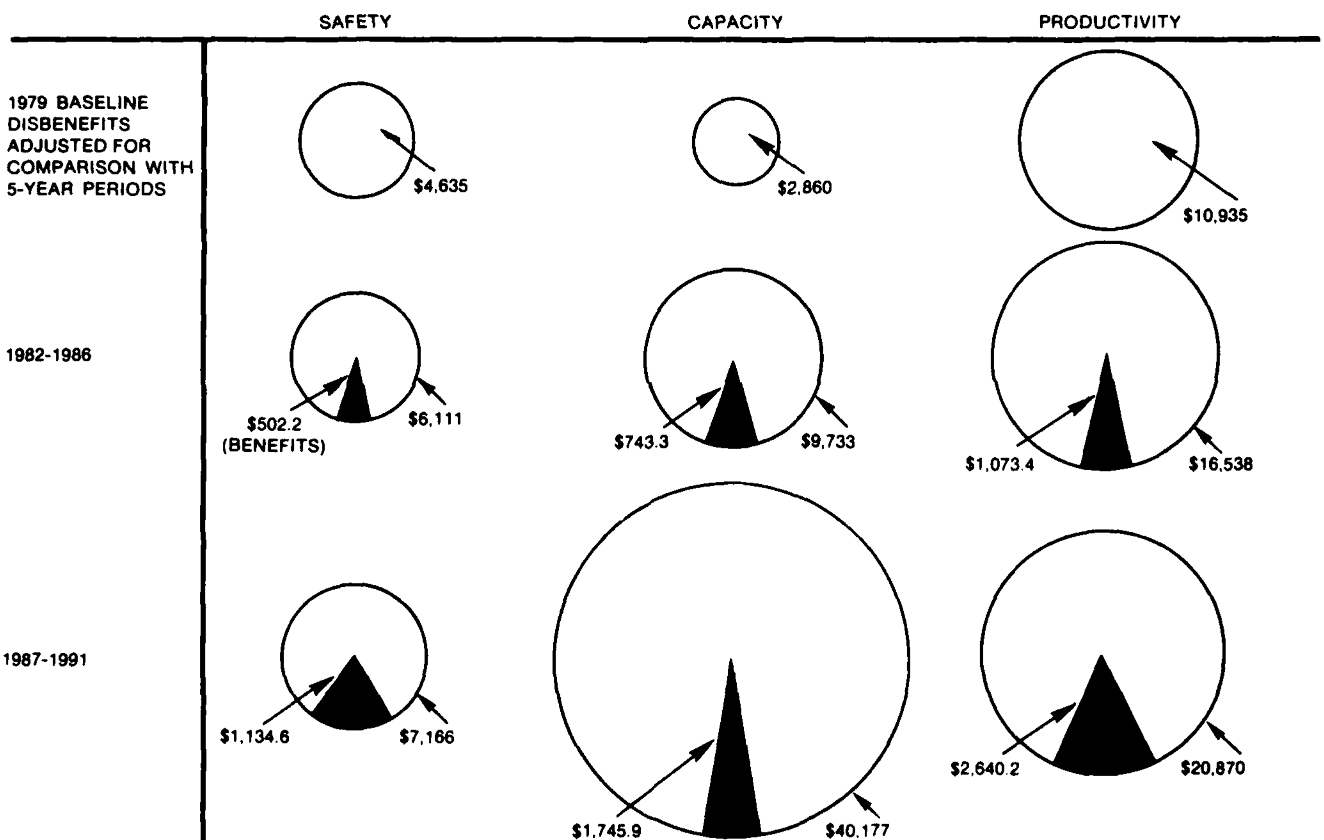
1. IN MILLIONS OF CONSTANT 1980 $'s.
2. BENEFITS INCLUDE PREVIOUS ALTERNATIVES.
3. THE CIRCLES REPRESENT THE DOLLAR DISBENEFITS ACCRUED IF NO CAPITAL INVESTMENTS ARE MADE FOR EXPANDED, NEW OR MODERNIZED FACILITIES.
4. SHADED AREA IN EACH CIRCLE REPRESENTS THE BENEFITS TO BE ACHIEVED FROM CAPITAL INVESTMENTS.

their benefits are entered into the analysis as equal to their costs. The results for this alternative are questionable to the extent this assumption is in error.

This alternative requires funding of $3.2 billion over the 1982-1986 period and $4.5 billion over the 1987-1991 period. At annual equivalent rates, this amounts to $643 million and $909 million for the two periods, respectively. Figure III-10 indicates that additional benefits are foreseen primarily in the areas of safety and capacity. For the 1982-1986 period, it is anticipated that delays can be reduced about $743 million and accidents about $502 million. For the 1987-1991 period, substantially larger benefits are projected. Delays should be reduced about $1,746 million and accident costs about $1,135 million. In terms of delay hours and fatalities, this alternative should avoid 1219 thousand hours of delay and prevent 3501 fatalities over the 1982-1991 period. While the programs included in this alternative make only a small direct contribution to productivity, they establish a technical base which is necessary for future productivity improvements. For example, the Discrete Address Beacon System will provide increased surveillance accuracy necessary for advanced air traffic control techniques which provide for productivity improvements. These new techniques are expected to be available following the ARTCC Computer Replacement Program.

FIGURE III-10

BENEFITS ACHIEVED FROM EXPAND SYSTEM USING NEW TECHNOLOGY ("EXPANSION - NEW TECHNOLOGY")



NOTES:

1. IN MILLIONS OF CONSTANT 1980 $'s.
2. BENEFITS INCLUDE PREVIOUS ALTERNATIVES
3. THE CIRCLES REPRESENT THE DOLLAR DISBENEFITS ACCRUED IF NO CAPITAL INVESTMENTS ARE MADE FOR EXPANDED, NEW OR MODERNIZED FACILITIES
4. SHADED AREA IN EACH CIRCLE REPRESENTS THE BENEFITS TO BE ACHIEVED FROM CAPITAL INVESTMENTS.

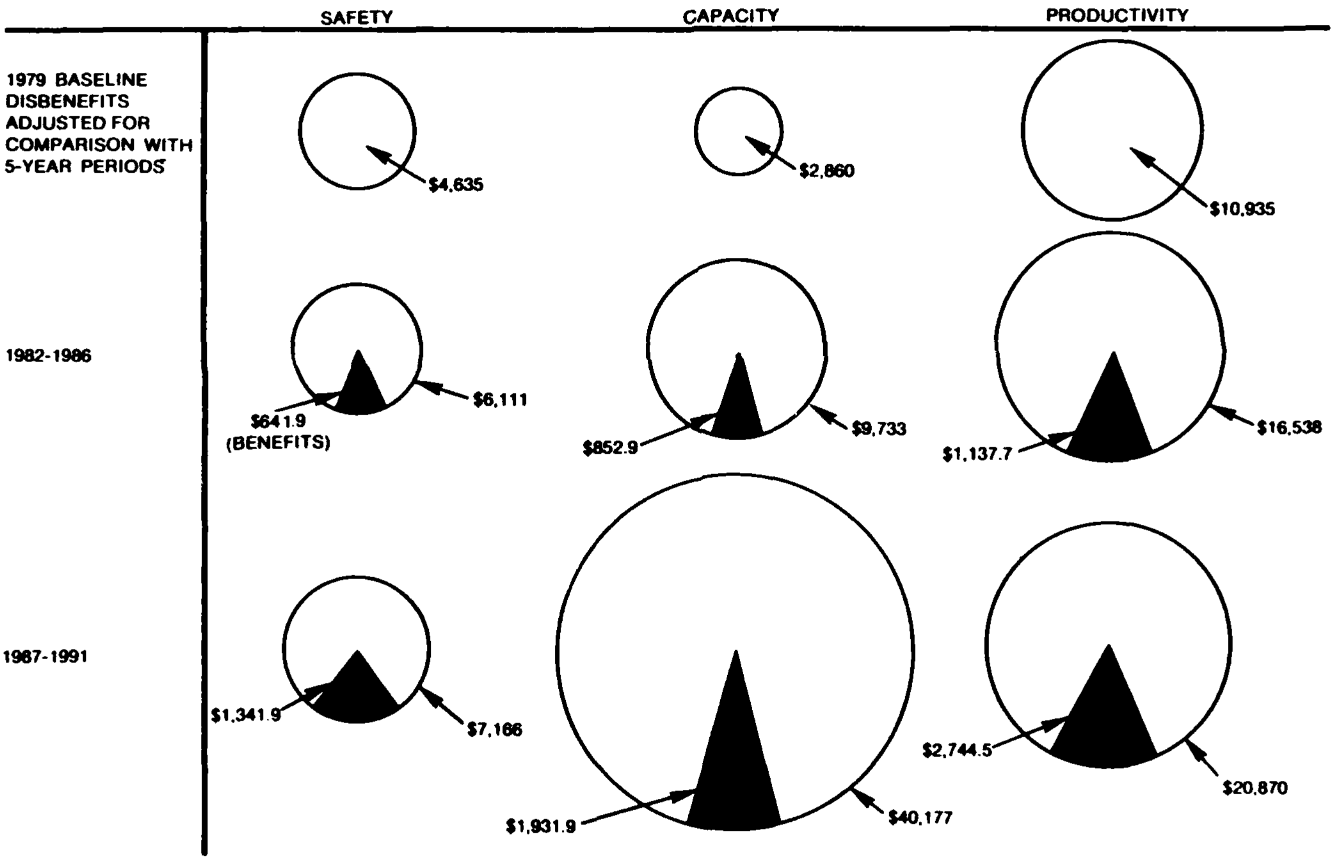
5. <u>Quality Improvements.</u> The "Quality Improvements" strategy differs from the others in that it can be undertaken independently. It is estimated to cost $475 million between 1982 and 1986 and $296 million over the 1987-1991 period, or about $95 million and $59 million, respectively, at annual rates.

This alternative is primarily safety and capacity oriented. Over the 1982-1986 period, this will reduce accident costs by an additional $140 million, delay costs by $110 million and operating costs by $64 million. From 1987 to 1991, the additional respective accident, delay, and operating cost reductions are $207 million, $186 million and $104 million. Over the entire ten year time span, it is projected to prevent an additional 741 fatalities and 145 thousand hours of delay. The impact of this alternative added to the other alternatives may be seen in Figure III-11.

An alternative calculation of benefits achieved from the total investment shows that for the 1982-1986 period 43 percent of the increase in safety disbenefits, 12 percent of the increase in capacity disbenefits, and 20 percent of the increase in productivity disbenefits are satisfied. In addition, during the 1987-1991 period, the benefits achieved from F&E investments satisfy 53 percent of the increase in safety disbenefits, 5 percent of the increase in capacity disbenefits and 28 percent of the increase in productivity disbenefits.

FIGURE III-11

BENEFITS ACHIEVED FROM TOTAL INVESTMENT PROGRAM



NOTES:

1. IN MILLIONS OF CONSTANT 1980 $'s.
2. THE CIRCLES REPRESENT THE DOLLAR DISBENEFITS ACCRUED IF NO CAPITAL INVESTMENTS ARE MADE FOR EXPANDED, NEW OR MODERNIZED FACILITIES.
3. SHADED AREA IN EACH CIRCLE REPRESENTS THE BENEFITS TO BE ACHIEVED FROM CAPITAL INVESTMENTS.

6. <u>Summary.</u> Total F&E expenditure requirements in constant 1980 dollars for the 1982-1986 and 1987-1991 periods are summarized in Figure III-12. These estimates indicate the cost of F&E investment projects over time net of inflation. The table also shows an estimate for current year dollars.

Benefit estimates associated with each investment alternative are summarized in 1980 dollars for 1982-1986 and for 1987-1991 in Figure III-13. In addition to totals, benefit allocations for major output categories are indicated. As can be seen, if all the investments outlined above were pursued, system performance over the 1982-1986 period will be improved by $642 million in the area of safety, $853 million in capacity, and $1,138 million in operating cost. For the 1987-1991 period, the respective improvements are $1,342, $1,932, and $2,745 million.

(3) <u>Airport Capital Investments.</u>

a. <u>Background.</u> Even if substantial capital investments are made in FAA facilities over the next decade, significant system capacity problems remain. Airport development will be a key to solving this capacity constraint.

Under the Airport and Airway Development Act of 1970, as amended which expired September 30, 1980, the FAA provides airport development grants on a cost share basis with state and local governments. In December 1980, replacement legislation for the 1970 Act was pending before Congress.

FIGURE III-12

Required Facilities and Equipment Expenditures a/

(Millions)

Alternative Total	Dollars	82-86 d/	87-91 d/	82-91 d/
Physical Wear Out	Constant 80 b/	$ 184.6	$ 261.9	$ 446.5
	Current (w. inf) c/	260.3	515.1	775.4
Economic Replacement	Constant 80	1443.5	2562.4	4005.9
	Current (w. inf)	2035.6	5040.5	7076.1
Expansion — Existing Technology	Constant 80	2853.7	3722.7	6576.4
	Current (w. inf)	4024.3	7323.0	11347.3
Expansion — New Technology	Constant 80	3214.1	4525.3	7739.4
	Current (w. inf)	4532.5	8901.7	13434.2
Quality Improvement	Constant 80	475.1	295.5	770.6
	Current (w. inf)	670.2	581.3	1251.5
TOTAL e/	Constant 80	$3689.2	$4820.8	$ 8510.0
	Current (w. inf)	$5202.7	$9483.0	$14685.7

---

a/ Costs do not include operations and maintenance costs (or savings).

b/ Constant 1980 dollars

c/ Current dollars inflated at rates estimated by Wharton Econometric Forecasting Associates

d/ The totals are cumulative in that "Expansion — New Technology" includes all previous alternatives, "Expansion — Existing Technology" includes all previous alternatives, etc.

e/ Total includes only "Expansion — New Technology" and "Quality Improvement."

FIGURE III-13
BENEFITS ACHIEVED BY F&E PROGRAMS a/
In 1982-1986 and 1987-1991
(Millions of 1980 Dollars)

	Total Benefit 1982-86	Total Benefit 1987-91	Safety 1982-86	Safety 1987-91	Capacity 1982-86	Capacity 1987-91	Productivity 1982-86	Productivity 1987-91	Energy/Environment 1982-86	Energy/Environment 1987-91
Physical Wear Out	114.6	277.3	28.5	70.3	28.5	70.3	56.2	133.2	1.4	3.5
	(391.9) b/		(98.8)		(98.8)		(189.4)		(4.9)	
Economic Replacement	898.6	2490.4	114.7	257.1	42.1	130.9	703.1	2026.6	38.7	75.8
	(3389.0)		(371.8)		(173.0)		(2729.7)		(114.5)	
Expansion -- Existing Technology	1978.3	4357.9	384.9	754.0	487.2	916.7	1061.8	2603.0	44.4	84.2
	(6336.2)		(1138.9)		(1403.9)		(3664.8)		(128.6)	
Expansion -- New Technology	2363.4	5604.9	502.2	1134.6	743.3	1745.9	1073.4	2640.2	44.5	84.2
	(7968.3)		(1636.8)		(2489.2)		(3713.6)		(128.7)	
Quality Improvements	314.7	498.1	139.6	206.9	109.6	186.0	64.3	104.2	1.2	1.0
	(812.8)		(346.5)		(295.6)		(168.5)		(2.2)	
TOTAL c/	2678.1	6103.0	641.8	1341.5	852.9	1931.9	1137.7	2744.4	45.7	85.2
	(8781.1)		(1983.3)		(2784.8)		(3882.1)		(130.9)	

a/ Benefit/cost ratios cannot be accurately computed from the data shown in this figure and Figure III-12. Cumulative benefits represent only those which accrue during the 1984-91 time period and do not include life cycle payoffs beyond 1991. Similarly, costs shown in Figure III-12 do not include life cycle components such as operation and maintenance costs.

b/ Numbers in parenthesis are totals for FY 1982-91 period.

c/ Totals include only "Expansion--New Technology" and "Quality Improvements."

b. Capacity Deficits at Major Airports. The FAA has studied the need for additional airport capacity and concluded that as many as 19 major new air carrier airports may be needed to accommodate air traffic forecast through the year 2000. However, because of the lack of acceptable sites, high costs, and public opposition to increased aircraft noise exposure, it is uncertain whether all the airports will be built.

Air carrier operations in most cities will continue to be accommodated at existing airports. It is possible to construct parallel runways at some airports to increase their capacity. In addition, measures may be taken to make more efficient use of limited capacity. This can be accomplished by using larger aircraft with greater seating capacity, increasing load factors, and spreading traffic demand evenly throughout the day. It may also be possible to divert small aircraft to reliever airports, or to provide short runways for their use at certain large air carrier airports. Measures such as these will be important factors in controlling aircraft delays during the 1980's.

D. INVESTMENT LEVELS.

(1) Airport Development Needs. The Nation's airport development needs are identified in the FAA's National Airport System Plan (NASP). The NASP includes all civil airports with scheduled commercial passenger service (including those served by large and small air carrier and commuter type aircraft) plus those locations where there is sufficient demand to warrant a publicly owned general aviation airport, as shown in Figure III-14.

FIGURE III-14
NASP - Number of Locations By Service Level

Service Level	Existing Airports	New Airports 0-5 Yrs.	New Airports 6-10 Yrs.	Total Locations 0-5 Yrs.	Total Locations 6-10 Yrs.
Air Carrier	635	13	5	650	643
Commuter Service	145	6	0	186	215
Reliever	155	46	6	206	212
General Aviation	2224	401	1	2583	2551
TOTAL	3159	466	12	3625	3621

The NASP includes 1 to 5 and 6 to 10 year estimates of the development eligible for Federal aid under the Airport Development Aid Program (ADAP). This includes such items as land acquisition, runway, taxiway and apron construction, airfield marking and lighting, approach aids that have not been identified for funding under the FAA's Facility and Equipment Program, safety equipment, and the public use nonrevenue producing portion of air carrier terminal buildings.

As a rule, major items of airport development are included in the NASP only when there is some reasonable expectation that they will actually be accomplished. For instance, only two of the nineteen major new airports previously mentioned are currently included in the NASP.

Three adjustments must be made to the NASP in order to represent the full range of future airport investment needs:

- The cost of development shown in the 6-10 year period must be increased to compensate for the lack of complete planning for that time period.

- The cost of development that was not eligible for Federal aid under the ADAP must be included.

- All costs must be adjusted upward to account for inflation.

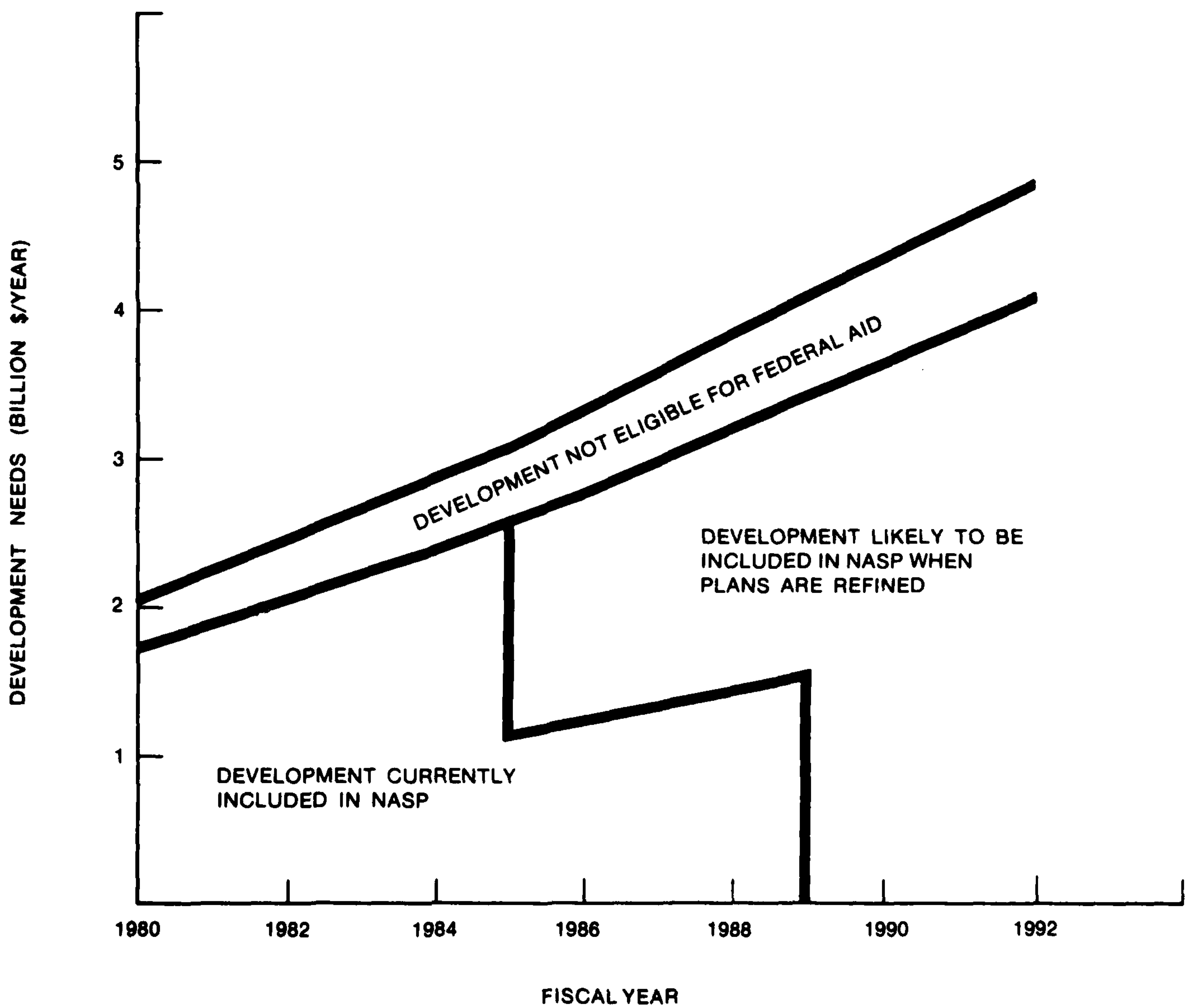
The development recommendations listed in the published NASP for the 6-10 year period are less complete than those for the shorter range, 1-5 year period, because of the greater difficulty in forecasting needs more than a few years in advance. As a result, the NASP shows uninflated investment requirements during the 6-10 year period that are only about half as much as the requirements of the first five years. In order to compensate for the incomplete nature of the longer term plans, the uninflated investment needs for that period should be increased to equal the level of the first five years.

Since the NASP only includes development that was eligible for Federal aid under the ADAP, it excludes the cost of other necessary airport development such as the revenue producing part of the terminal building, parking lots, hangars, and air cargo buildings. A study 1/ recently prepared for the FAA examined these costs and developed a method for estimating them which was used to develop Figure III-15.

1/ Investment Needs and Self-Financing Capabilities: U.S. Airports Fiscal Years 1981-1990, Crenshaw and Dickinson, July 1978, Order No.: WI-78-3421-1.

FIGURE III-15

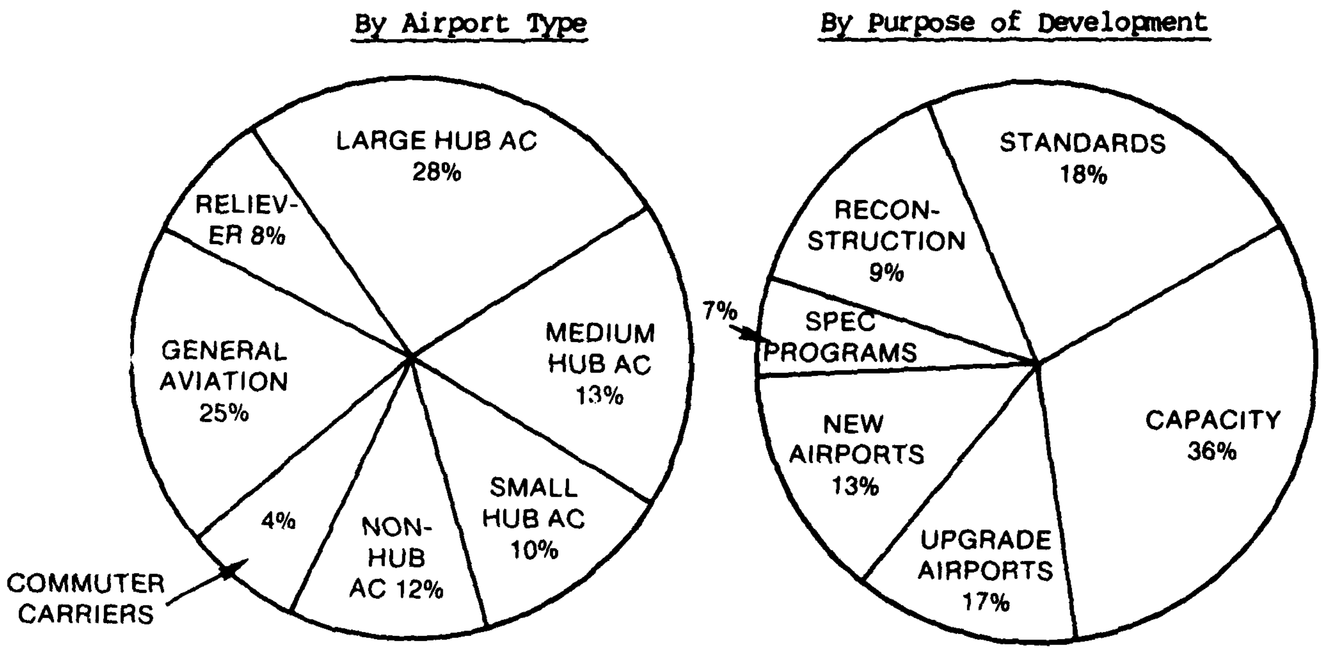
ANNUAL AIRPORT DEVELOPMENT NEEDS
(CURRENT YEAR DOLLARS)



Finally, the development needs, which were originally estimated in terms of 1979-1980 development costs, were inflated using April 1980 data from the Wharton Forecasting Model. The total inflated development cost for the ten year period from 1982 through 1991 is estimated at $36 billion, of which $30 billion would probably be eligible for Federal aid.

The NASP not only identifies the airport development needs that are eligible for Federal aid, but also classifies them by type of airport and purpose of development. As shown in Figure III-16, 67 percent of all NASP needs are at airports with scheduled passenger service. Figure III-16 also breaks down NASP recommendations into the following categories: (1) reconstruction and replacement of aging or deteriorated facilities, (2) development needed to bring airports up to current FAA design standards, such as providing adequate clearance between runways and taxiways and providing adequate pavement widths, (3) development needed to increase the capacity of congested airports, (4) development needed to accommodate larger or more demanding aircraft, such as runway extensions and pavement strengthening, (5) new airport construction to increase system capacity, replace substandard airports, or provide access to rural communities, and (6) special emphasis programs such as providing fire and rescue equipment and meeting airport security needs. Safety is not indicated as a separate category because it is a consideration in almost every item of development. For instance, reconstruction is often recommended when facilities deteriorate and approach an unsafe condition. Safety is the primary objective of FAA design standards, and capacity development is aimed at reducing congestion, which, if not relieved or controlled, may result in an unsafe environment for aircraft operations.

FIGURE III-16
Distribution of National Airport System Plan (NASP) Costs



AC = Air Carrier

(2) Facilities and Equipment.

a. Trends and Projections. As previously indicated, investment in FAA Facilities and Equipment (F&E) has declined substantially in constant dollars over the past decade (Figure III-4). While actual dollar levels have remained reasonably constant, the impact of inflation has reduced the purchasing power of these dollars to barely a third of FY-1972 levels. This decline in real capital investment occurred during a period of significant growth in aviation activity and a consequent doubling in the demand for aviation services.

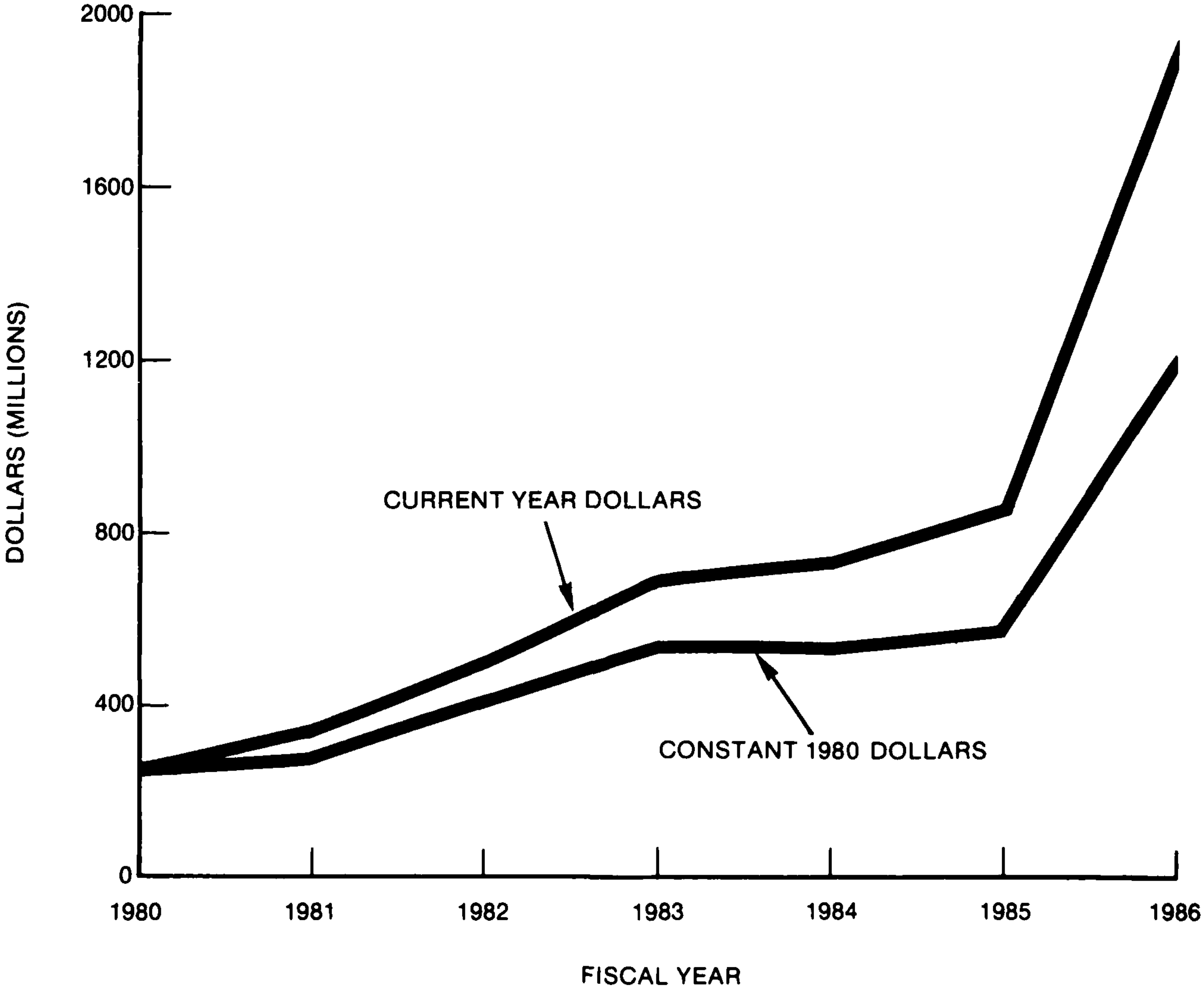
This level of F&E investment over the past decade has resulted in an aging inventory of equipment, requiring higher levels of maintenance attention and increased costs. Continued low investment levels will result in an inability to provide enhancements in system safety, capacity and productivity, as well as a reliance upon older equipment whose costs will rapidly escalate in the next decade.

b. Basic Needs. The F&E estimates contained in this document are based on an appraisal of what must be invested in the coming decade to prevent a significant deterioration of system performance. The levels of F&E investment shown in Figure III-17 have been established based on an assumption of favorable cost-effectiveness assessments of major systems detailed in both the alternatives "Expansion—New Technology" and "Quality Improvement" of the preceeding section.

These year-by-year assessments demonstrate a substantial net benefit from the proposed investments. While considerable gains in safety and delay reduction are expected, even greater gains will come through increased operating effectiveness as the system is modernized. Most of the programs planned, in fact, are intended to bring the 25-30 year old capital plant up to modern standards. If these investments are not made, inefficiencies and safety related problems will increase as the equipment deteriorates. Capacity gains from the planned investments are expected to result mostly from the continuing establishment of new current technology systems such as airport surveillance radars and air traffic control towers. When contrasted with projected levels of operations growth, it is apparent that the planned F&E investments will at best yield continued operation of the system at present performance levels and provide a modern technology base on which to build solutions to future year problems. The ten year aviation forecasts leave little doubt that some portions of the NAS will develop severe capacity constraints by the end of the decade. Failure to provide the planned system improvements will aggravate capacity-related delays and result in unacceptable derogations of aviation safety.

FIGURE III-17

F&E FUNDING REQUIRED TO ACHIEVE PROPOSED IMPROVEMENTS TO THE NATIONAL AIRSPACE SYSTEM



(3) Research, Engineering and Development.

a. Trends and Problems. In the early part of 1980, an analysis was made of the funds needed in the Research, Engineering and Development (R,E&D) appropriation to support improvements in the National Airspace System (NAS). That analysis indicated that the fiscal year funding would have to increase steadily, in terms of constant 1980 dollars, from the $80M in the FY-1980 appropriations to $110M in FY-1985 exclusive of funds needed to support two recent major additions to the program - Next Generation Weather Radar (NEXRAD) and the computer replacement program.

Figure III-18 presents a more detailed assessment of the funding requirements for the next ten years. The lower line in this figure ($115M in FY-1986) represents the requirement for the basic R,E&D programs in terms of constant FY-1980 dollars, the next upper line ($200M in FY-1986) shows the amount that will have to be appropriated to support the basic program adjusted for inflation. The top line, ending at $233M in FY-1986, shows the appropriation needed to support the basic R,E&D effort which includes NEXRAD plus the computer replacement program.

b. Basic Needs. Aviation growth forecasts and the problems facing the aviation industry suggest substantial payoffs may be achieved as a result of successful accomplishment of a well structured research, engineering and development program to realize the following objectives:

- Find new ways for enhancing safety for all users, but especially for general aviation, where long-range growth will bring greater pressure to substantially reduce the number of accidents.

AD-A122 164 NATIONAL AVIATION SYSTEM DEVELOPMENT AND CAPITAL NEEDS 2/2
FOR THE DECADE 1982 - 1991(U) FEDERAL AVIATION
ADMINISTRATION WASHINGTON DC OFFICE OF AVIATION POLICY
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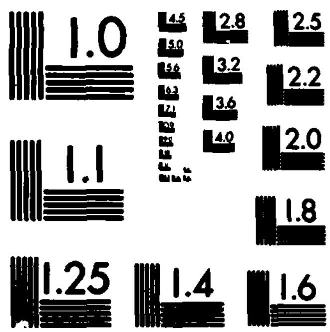
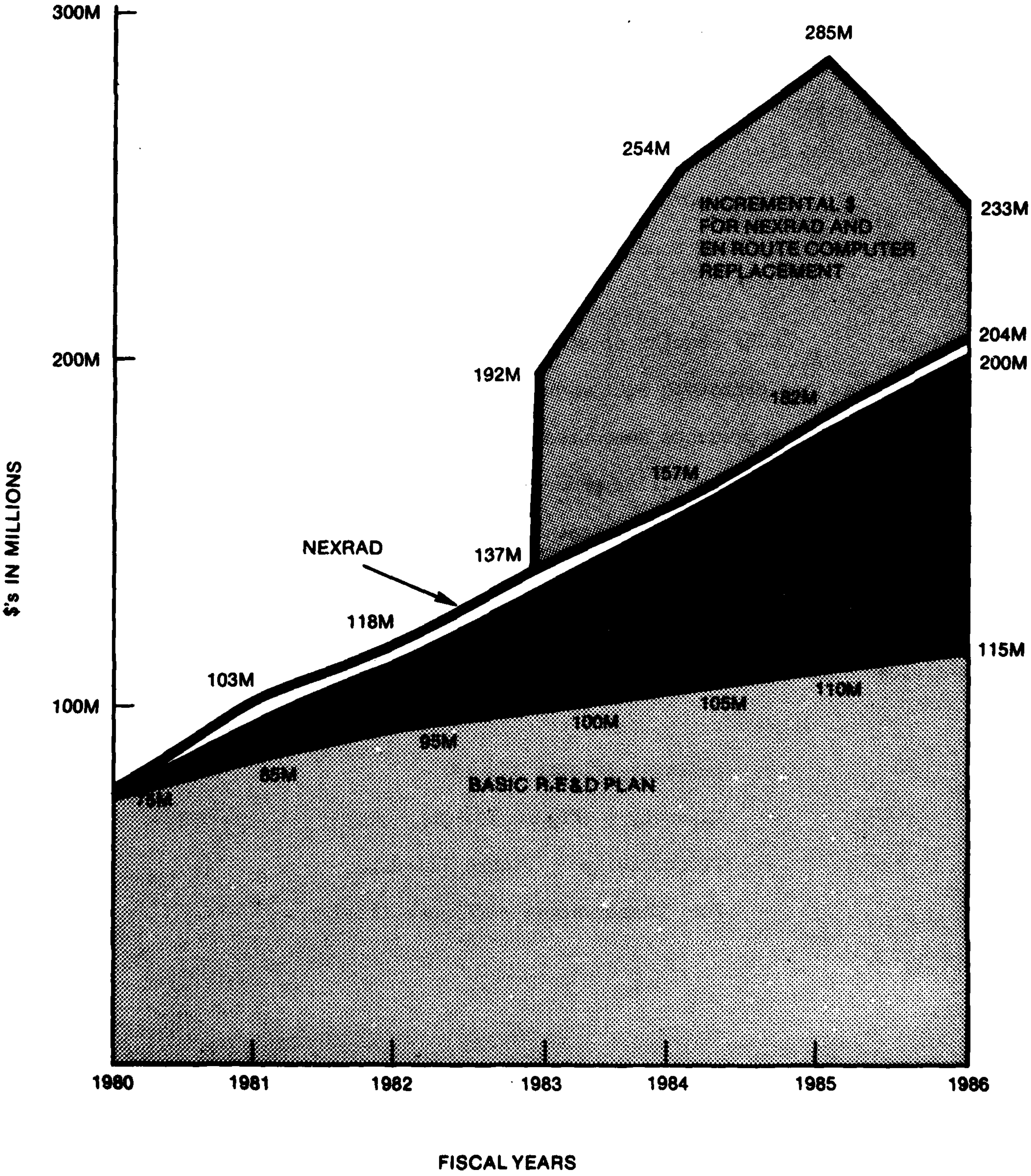


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FIGURE III-18

R,E&D FUNDING REQUIRED TO SUPPORT PROPOSED IMPROVEMENTS TO THE NATIONAL AIRSPACE SYSTEM



- Provide substantial increase in system capacity and reduce delays, especially in the airport, terminal airspace, and in the landside areas.

- Substantially increase system performance and productivity and reduce the rate of increase in cost for users to fly in the system.

- Improve efficiency in the use of airspace in order to reduce fuel consumption and further reduce delays.

The results of studies performed, test and evaluation of breadboard and prototype equipment and actual field operational tests of a number of E&D products demonstrate a potential for significant gains in safety, capacity, controller productivity, efficient use of airspace, and an associated reduction in certain FAA user costs.

The Research, Engineering and Development programs are divided into four areas as they relate to:

- Safety - (Figure III-19)
- Capacity - (Figure III-20)
- Productivity - (Figure III-21)
- Fuel Conservation - (Figure III-22)

FIGURE III-19
R,E&D Safety-Related Activities

TECHNICAL GOALS	E&D ACTIVITY
Mid-Air Collisions	
Automate controller and pilot separation advisory service	- E&D Separation Assurance Program: Discrete Address Beacon System (DABS); Beacon Collision Avoidance System (BCAS, Active and Full); Automatic Traffic Advisory Resolution Service (ATARS); Terminal Automation Improvement (Conflict Alert for ARTS II); Automated Enroute ATC (AERA) - Alternative Separation Concepts - Control Message Automation (CMA) - Conflict Resolution
Approach and Landing Accidents	
Improve precision approach systems	- MLS
Alert pilot of flying too low	- ATC automatic terrain avoidance advisories via DABS
Reduce problem in making transition from instruments to visual contact	- Advanced Techniques (consolidated cockpit design, Head-Up Display (HUD), Cockpit Display of Traffic Information (CDTI)
Reduce weather related accidents	- Flight Service Automation System - Automated Weather-detection, prediction, dissemination - Doppler Weather Radar - Wind Shear Detection and Avoidance
Terminal Area and En Route Accidents	
Alert pilot of hazardous flight	- ATC automatic advisories via DABS

Improve weather information, provide hazardous Wx information to pilots and controllers	- Flight Service Automation System - Weather detection, prediction dissemination - Next Generation Weather Radar (NEXRAD) - Terminal Wx Radar Development - Automated weather advisory via data link - Airborne doppler weather radar

<u>Airport Surface Accidents</u>

Improve ground controller surveillance	- Airport Surface Traffic Control (ASTC)/Terminal Automated Ground Surveillance System (TAGS)
Reduce Runway Transgressions	- Runway Transgressions Analysis
Improve runway traction	- Airport runway grooving and cleaning

<u>Other Accidents</u>

Improve pilot performance	- Aircraft Pilot Performance Enhancement and Error Reduction (APEER) - Pilot training - A/C alerts and warnings - Pilot physiological considerations - Pilot/ATC controller interface factors
Improve controller performance	- Controller Performance Enhancement and Error Reduction (CPEER) Controller Specialists Selection procedures - Improved Controller Training
Handicapped considerations	- Provide R&D to support better services to handicapped passengers

FIGURE III-20
R,E&D Capacity Related Activities

Technical Goals	E&D Activity
Increase Airport Capacity	
Develop capability of detecting/predicting conditions where longitudinal separation standards may be reduced without degrading safety due to possible encounter with high energy wake vortices.	- Wake Vortex Avoidance System (WVAS)
Improve accuracy in the delivery of aircraft to the runway threshold and maintain closer tolerances in separation of aircraft during approach.	- Airport Capacity Delay Program - Terminal Integrated Flow Management - Integrated Flow Management (IFM)
Minimize the impact of low visibility on the ability of the local controller and ground controller to control surface traffic and to determine when the runway is clear for another operation.	- Airport Surface Traffic Control (ASTC) System - Terminal Automated Ground Surveillance System (TAGS) - Airport Transgression
Reduce operational constraints associated with the use of today's VHF Instrument Landing System at some airports.	- Microwave Landing System
Provide wake avoidance information	- Wake Vortex Avoidance System (WVAS)
Increase Efficiency In Airspace Utilization	
Minimize enroute distance and delay from gate of departure airport to landing.	- Integrated Flow Management - En Route Metering - Airport Configuration - Management - Terminal Integrated Flow Management - Central Flow Control
Evaluate ATC/Airport Airside Capacity Versus Ground Transportation Landside Capacity	
Develop capacity/delay models for both airside and landside analysis.	- Airport Airside and Airport Landside capacity/delay models - Airport Requirements

Improve Existing ATC Navigation Systems

Prevent Proliferation of Navigation Systems and provide improved services to users.	- Federal Navigation Planning - OMEGA - LORAN C - Criteria for Navigation Standards - Future Navigation Systems - NAVSTAR/GPS
Improve Helicopter Operations	- Improved Helicopter Navigation - Improved Helicopter Wx Detection - Improved Helicopter Communications - Improved Helicopter Procedures - Improved Heliport Lighting - Improved wake vortex detection

Future ATC System Architecture

Upgrade Existing ATC System Capacity	- En Route and Terminal Computer Replacement Program - En Route Display Processor Improvements

FIGURE III-21
R,E&D Elements To Increase Productivity

Technical Goals	Activity
Improve Controller Productivity	
Pursue a development program that will make evolutionary improvements to the semi-automated en route, terminal area and central control facilities to increase the overall productivity of the facilities.	- Electronic Tabular Display - Automated Flight Data Handling and Distribution - Metering and Sequencing in Terminal Areas - Automatic Generation and Delivery of ATC Messages (DABS/D/L/) - AERA - Flight Data and Display (FDAD) - Terminal Information and Display System (TIDS)
Reduce Costs and Improve Services At Flight Service Stations	
Automate some of the weather inputs to FSS's	- Automated Weather Observation Systems
Automate and consolidate FSS's at 61 locations	- Flight Service Station Program
Develop ways for pilots to receive automated briefings via inexpensive briefing terminals	- Pilot Self Briefing System
Reduce Maintenance Costs	
Analyze how maintenance procedures might be changed as more reliable equipment is installed to reduce maintenance costs	- Future Maintenance Concepts (RMMS)
Reduce ADAP costs of rebuilding runways	- Improved Airport Pavement Designs
Near Term ATC Communications Improvements	
Replace existing voice communications systems	- SVSS - Tone Channeling Improvements - FSS VSCS - Terminal VSCS - En Route VSCS
Improve existing data communications systems.	- NADIN Enhancements

FIGURE III-22
E&D Conservation Activities

Technical Goal	E&D Activity
Eliminate energy wasteful climb descent procedures	- Integrated Flow Management (IFM) - Metering and Sequencing (M-S) - Wake Vortex Avoidance System (WVAS)
Reduce energy consumed due to nonoptimum en route procedures	- Integrated Flow Management (IFM) - Oceanic Route Structure Analysis - En Route Metering - Advanced En Route Automation (AERA)
Reduce energy consumed due to inefficient taxiway/runway control procedures	- Airport Surface Traffic Control (ASTC) - Airport Surface Detection Equipment (ASDE III) - Terminal Automated Ground Surveillance System (TAGS)

E. <u>SUMMARY OF NEEDS.</u> Over the coming decade, aviation is expected to grow substantially. Agency forecasts show that activity will increase by about 40 percent while enplanements will be up about 50 percent for air carriers and 170 percent for commuters. This growth will result in substantial declines in system performance unless major capital investments are undertaken. In the absence of such investment, the 1982-91 period will see accident losses accumulate to $4 billion over current levels, delays costs total an additional $44.2 billion, and operations costs amount to $15.5 billion more than would occur at current cost levels.

The system performance that is expected over the 1982-91 period will be a direct function of the capital expenditures committed to improving and expanding the air traffic control system, refurbished and improved existing airports, construct new airports, and support research and development programs. Costs of alternative investment programs across the 1982-1991 period are summarized in Figure III-23.

Facilities and Equipment expenditures projected for the air traffic control system are shown at five levels. The first two represent different levels of replacement investment. The second two identify increased funding of system expansion and the last represents quality improvements to services provided to users. All levels are cumulative except the last, which must be added to the others to produce the total. The specific programs included in these five levels of investment are listed in Appendix I.

FIGURE III-23

Federal Funding Needs 1982-1991
(Billions of Dollars)

	Current Dollars (Wharton Estimate)	Constant 1980 Dollars
Facilities and Equipment		
Physical Wear Out	$ 0.8	$ 0.4
Economic Replacement	7.1	4.0
Expansion--Existing Technology	11.3	6.6
Expansion--New Technology	13.4	7.7
Quality Improvement	1.3	0.8
Total F&E Program a/	$ 14.7	$ 8.5
Airport Grants-In-Aid Program b/	$ 9.8	$ 5.9
Research, Engineering and Development Program	$ 2.6	$ 1.6
TOTAL	$ 27.1	$ 16.0

a/ Total includes only "Expansion--New Technology" and "Quality Improvement"
b/ Figures shown are Federal share and represent 80 percent of total required funding

The Grants-In-Aid investments for existing airport improvements and construction of new airports were estimated based on the trend of funding levels in the pending legislation. The total Federal funding share is estimated to reach approximately $6 billion over the 1982-91 period in constant 1980 dollars.

Figure III-24 summarizes system performance levels which can be expected under each of several Facilities and Equipment (F&E) investment levels, assuming no airport program investments. An investment of over $8 billion from the F&E appropriation (in constant 1980 dollars) is necessary to prevent a drastic decline in overall system performance. Performance decline is largest with respect to delay for the 1982-1991 period and indicates that in addition to required facilities and equipment expenditures, advances must be made in other areas as well.

Central to the resolution of the projected delay problem is the provision of additional airport capacity. Current agency estimates indicate that as many as 14 major airports may reach capacity limits by 1990 and that this number may reach 19 by the year 2000. This will occur even with the maximum Facilities and Equipment expenditures shown in Figure III-23. The number of congested airports may be reduced somewhat if current strategies to divert general aviation aircraft to reliever airports are successful and if the concept of providing separate, non-interfering general aviation facilities at major airports proves to be workable. In addition, the implementation of peak spreading can be expected to postpone the onset of congestion at a number of airports. However, even if all of these attempts to deal with the problems are

FIGURE III-24

SYSTEM PERFORMANCE UNDER ALTERNATIVE FACILITIES AND EQUIPMENT EXPENDITURE OPTIONS
(Millions of 1980 dollars)

	No Investment (1)	Physical Wear Out (2)	Economic Replacement (3)	Expansion--Existing Technology (4)	Expansion--New Technology (5)	Total Program a/ (6)
1982-1986						
Accident Cost	6,111	6,083	5,996	5,726	5,609	5,469
Delay Cost	9,733	9,705	9,691	9,246	8,990	8,880
Operating Cost	16,538	16,482	15,835	15,476	15,465	15,400
1987-1991						
Accident Cost	7,166	7,096	6,909	6,412	6,031	5,824
Delay Cost	40,177	40,107	40,046	39,260	38,431	38,245
Operating Cost	20,870	20,737	18,843	18,267	18,300	18,126

a/ Total includes "Expansion--New Technology" and "Quality Improvements" successful, eleven major airports are still forecast to have significant delay problems by the year 2000. Note that if the new airport investments shown in Figure III-23 would have been made so as to allow the airports to become operational by the mid-eighties, most of the projected capacity shortages would never materialize.

Overall, the capital needs of the aviation system during the decade ahead are substantial. If we fail to meet these needs, capacity will threaten efficient system operation with the severe bottlenecks predicted to be large air carrier airports in several major metropolitan areas. The air traffic control and air navigation system will become a major constraint unless increased levels of capital are put into modernization, improvement, and new technology. With sufficient investment, this need not be the case.

F. PROBLEMS AND OPPORTUNITIES. For at least a decade FAA's capital investment levels have been steadily eroded in terms of constant dollars. Significant increases in Grants-In-Aid, F&E, and R,E&D are needed to refurbish the existing system, provide for future growth and establish a base from which to evolve to the next generation of air traffic control and air navigation. However, currently planned efforts will not completely solve the airport delay problem. Other initiatives are needed to identify other investments and/or noncapital programs that might be used to advantage. A number of programs including runway construction, revised operating procedures, and advanced development may need to be moved forward on a priority basis. Some of the advanced technological and operating concepts which have high potential have previously been described in Figures III-19 through 21.

It is tempting to adopt an optimistic view of the future and assume the problems will go away. Perhaps the forecast of activity is incorrect; perhaps fuel cost increases will slow down traffic growth; and perhaps airlines will shift or curtail schedules rather than incur projected delays. But even if "voluntary" schedule reductions are made, the nation still pays the costs in terms of a transport system which is needlessly inefficient. That the capacity problem is substantial is reflected in the fact that few additional gains are to be achieved by the introduction of yet larger aircraft or development of air traffic control procedures, both of which have made possible major improvements at the bigger hubs in the last few years. Even if traffic develops less quickly than projections indicate, or a problem materalizes more slowly than projected, the problem is merely delayed for a year or two and not solved.

Substantial investment is required in the system over the next decade, both in absolute and constant dollar terms if the efficiency of the air transport system is to be maintained.

CHAPTER IV: NATIONAL AVIATION SYSTEM PROGRAMS

A. GENERAL DESCRIPTION. Guaranteeing safe and efficient movement of aircraft is the foundation upon which the Nation's air transportation system is built. The quest for safety in aviation permeates all of FAA's activities and guides every decision. The safety impact is always the first measure applied to any program, even those without a direct safety goal, such as those designed to increase capacity, reduce aircraft noise, or improve controller productivity. These programs also include safety benefits just as safety programs often contribute toward the attainment of other goals.

The FAA's primary programs fall into seven major areas:

- En Route
- Terminal
- Flight Services
- Technical Support
- Research and Development
- Airports
- Personnel

Programs in these seven areas are described in the following paragraphs. With the exception of minor adjustments in the timing of a few capital projects, these programs are consistent with those included in the Chapter III needs analysis.

B. EN ROUTE. The en route system includes a comprehensive array of capital investment programs designed to provide needed system enhancements as well as replace obsolete equipment having high maintenance costs. It also includes development of the avionics capabilities that are companion items to some of the new ground systems, and the new avionics capabilities needed primarily for enhancement of collision avoidance capability in both terminal and en route airspace.

The most extensive capital investment programs to be completed during the 1982 through 1991 time period include replacement of the existing 9020 computers within each of the ARTCC's and the replacement of obsolete long range surveillance radars.

(1) En Route Computer Replacement. The computer replacement program is needed to accommodate higher levels of air traffic activity, to provide controllers with increased automation assistance, to increase productivity of the en route portion of the ATC system, and to minimize operational and maintenance costs of the en route computers.

The costs of this program are estimated to total:

	FY-80 Dollars		Current Year Dollars	
	F&E	R,E&D	F&E	R,E&D
- FY 1982-86	$ 400 M	$ 310 M	$ 625 M	$ 430 M
- FY 1987-91	$ 900 M	$ 56 M	$1800 M	$ 102 M

(2) Long Range Radars. Replacement of long range radar (ARSR-1 and ARSR-2) by state-of-the-art equipment is needed both to improve surveillance performance and to reduce maintenance and operational costs. Remote Maintenance Monitoring (RMM) and Moving Target Detection (MTD) capability is planned to be included in the new radars (ARSR-4's) and will be added to the existing solid state (ARSR-3) radars.

The F&E costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 230 M	$ 305 M
-	FY 1987-91	$ 220 M	$ 395 M

(3) Automation and Surveillance. Other significant capital investment programs aimed at replacement and/or enhancement of automation and surveillance capabilities of the en route part of the NAS include:

- Electronic tabular displays to replace the existing paper flight data strips at each en route sector.
- Remote maintenance monitoring for RCAG's and VORTAC's.
- Doppler Weather Radar.

The costs of these programs are estimated to total:

		FY-80 Dollars		Current Year Dollars	
		F&E	R,E&D	F&E	R,E&D
-	FY 1982-86	$ 70 M	$ 19.0 M	$ 100 M	$ 24 M
-	FY 1987-91	$ 70 M	$ 3.5 M	$ 125 M	$ 7 M

(4) Voice and Data Communications. Capital investment programs for the en route system will also include modernized voice and data communications capability. The Voice Switching and Control System (VSCS) and the National Airspace Data Interchange Network (NADIN) programs are the two largest portions of this effort, but replacement of tube-type amplifiers at each ARTCC and replacement of tube-type tone equipment at Remote Communication Air/Ground Facilities (RCAG's) are also important. All of the voice programs are designed to provide new solid state equipment to enhance reliability, voice-quality, and provide easy sector reconfiguration. NADIN provides a unified system for data interchange on

a nationwide basis. All programs, except for VSCS will be completed in the first five year period. VSCS will be accomplished in the second five years.

The costs of these programs are estimated to total:

		FY-80 Dollars		Current Year Dollars	
		F&E	R,E&D	F&E	R,E&D
-	FY 1982-86	$ 110 M	$ 49 M	$ 150 M	$ 65 M
-	FY 1987-91	$ 105 M	$ 45 M	$ 200 M	$ 87 M

(5) Navigation. The major establishment/replacement program for en route navigation during the early part of this ten year program involves the second generation (solid state) VORTAC system, which will have a remote maintenance monitoring capability and will significantly reduce maintenance costs. This program was funded prior to the start of the ten year period and installations should be completed by the mid 1980's. The R,E&D effort in support of long distance navigation, both CONUS and worldwide, will emphasize the experimental and analytical activity needed to formulate a 1982 preliminary United States recommendation regarding the mix of navigation systems for the 1990's and beyond. A final recommendation will be made in 1986 and will involve consideration of the role of VOR/DME, LORAN C, GPS and Omega beyond 1995.

The costs of these programs are estimated to total:

		FY-80 Dollars		Current Year Dollars	
		F&E	R,E&D	F&E	R,E&D
-	FY 1982-86	$ 65 M	$ 28 M	$ 85 M	$ 39 M
-	FY 1987-91	$ 75 M 1/	$ 41 M	$ 145 M	$ 82 M

1/ Future program dependent upon recommended alternatives.

(6) Automation Software. In addition to the new/replacement hardware items, development of software will be completed to provide for en route metering, conflict resolution, off loading of flight data processing to ETABS, automated clearance delivery, IFR/VFR conflict advisory service, integrated flow management and automated en route air traffic control.

The costs of these programs are estimated to total:

		FY-80 Dollars		Current Year Dollars	
		F&E	R,E&D	F&E	R,E&D
-	FY 1982-86	$ 65 M	$ 28 M	$ 80 M	$ 39 M
-	FY 1987-91	$ 60 M	$ 41 M	$120 M	$ 82 M

A listing of the improvement programs that will be made during both the first five years (FY 1982-86) and the following five years (FY 1987-91) is shown in Figure IV-1. All programs shown require an integrated and supporting developmental effort except for those identified by an asterisk. In those latter cases, the improvements will be attained by the purchase or relocation of facilities where development was completed with pre FY-1981 R,E&D funds or where facilities/equipment were available directly from industry without the need for FAA R,E&D programs. Programs are listed in two columns (1981-1986 and 1987-1991) according to the period when funds for F&E or R,E&D are required rather than when they will be completed. Programs shown in both columns indicate that funding will be required in both periods.

FIGURE IV-1
Summary of En Route ATC System Improvements
FY 1982-1991

	FY 1982 - 1986	FY 1987 - 1991
ARTCC	- En Route Metering - Direct Access Radar Channel (DARC) Enhancements - Enhance/Replace DYSIM* - Remote Maintenance Monitor System (RMMS) for RCAG's (Non-Sterile) - Flight Strip Printer (FSP) Replacement With Flight Data Input Output Equipment (FDIO)* - Sector Weather Displays - Weather Display Enhancements - Conflict Resolution Advisory	- Additional CWSU Enhancements - Center Weather Service Unit (CWA) - En Route Metering Enhancements - Additional Weather Display Enhancements - 9020 Replacement - Radar Console Improvements - IFR/VFR Conflict Advisory - Improve Traffic Simulation (RTF) - Electronic Tabular Display Sub-System (ETABS)
ATCSCC	- Teletypewriters Replaced By Data Terminal Equipment (DTE)* - Communications Processor At Jacksonville - Automated Weather Information System - Central Flow Control Enhancement	- Additional Central Flow Enhancements - ATCSCC Computer Replacement
EN ROUTE SUR-VEIL-LANCE	- RMMS For En Route Surveillance Sites	- Next Generation Weather Radar (NEXRAD) - Air Route Surveillance Radar* (ARSR-4) - Moving Target Detector (MTD)

NOTE: All programs are integrated F&E and R,E&D programs except those designated by an asterisk, which indicates no supporting R,E&D is required.

	FY 1982 - 1986	FY 1987 - 1991
VOICE COMMUN-ICATION	- Solid State Transmitters & Receivers & Higher Gain Antennas For All Air/Ground Sites* - Remote Communications Air/ Ground (RCAG) Remote Monitoring Subsystem (RMS)* - Maintenance Processor Subsystem (MPS)* - Voice Switching & Control System (VSCS) (Tone Signaling & Control System)	- VSCS (En Route)
DATA COMMUN-ICATION	- NADIN IA - Provides Data Communications For The Flight Service Automation System (Model II) & The Flight Data Input Output (FDIO System)	- NADIN Enhancements - Provides Data Communications For For National Flight Data Center (FINAL), Computer B, Modernized Weather Service, RMMS (MPS-MPS), DOT Data Communications Networks

NOTE: All programs are integrated F&E and R,E&D programs except those designated by an asterisk, which indicates no supporting R,E&D is required.

C. <u>TERMINAL.</u> The present terminal air traffic control system contains equipment twenty years old or more. During the ten year period from 1982 to 1991, much of this equipment will require replacement. Programs will focus on the replacement and improvement of older, obsolete and difficult to maintain surveillance and navigation equipment; the installation, relocation and upgrading of automated terminal ATC facilities; the initial implementation of MLS; and the upgrading of airports to better support commuter and general aviation operations. Actions will also be taken to provide for the ground equipment that will be needed to accommodate the use of Beacon Collision Avoidance System (BCAS) in terminal airspace.

During the latter part of the ten year period, the emphasis will shift to replacing of terminal data processing systems that will have been in use for well over twenty years by that time; adding improved weather observation and reporting equipment; completing the implementation of improved radar and beacon surveillance sensors and an associated separation assurance capability; adding remote maintenance monitoring capability to terminal facilities; continuing with the implementation of MLS; and adding new capabilities such as metering and sequencing, to the automated control facilities. The major programs involved in accomplishing improved and expanded facilities in the terminal area are described in the following sections.

(1) <u>Improve ARTS-II/IIIA.</u> The ARTS-IIIA facilities will be completed using funds from prior funding authorizations. During FY 1982-1986, the major expense will be in the upgrading of ARTS-IIIA and ARTS-II facilities to include a variety of improvements such as adding Conflict

Alert and Minimum Safe Altitude Warning to ARTS-II facilities, increasing capacity where needed, adding improved digital displays, adapting the tracking capability to make best use of new DABS surveillance inputs and the Terminal Information and Display System (TIDS). In the late 1980's, new data processing systems and associated facilities will be procured to replace the older obsolete equipment which is expected to become increasingly less reliable and more costly to maintain.

The costs of these programs are estimated to total:

	FY-80 Dollars		Current Year Dollars	
	F&E	R,E&D	F&E	R,E&D
- FY 1982-86	$ 150 M	$ 41 M	$ 205 M	$ 56 M
- FY 1987-91	$ 750 M	$ 93 M	$1400 M	$ 155 M

(2) Airport Surveillance. In the surveillance area, the older, obsolete and maintenance intensive ASR-4, 5 and 6's will be replaced by a new modern ASR-9 radar with an improved moving target detection (MTD) and remote maintenance monitoring (RMM) capability. MTD and RMM will also be added to existing ASR 7 and 8's. Implementation of the improved beacon surveillance system, DABS, will be initiated along with an associated and integrated capability for automatically providing aircraft traffic advisory, and resolution service (ATARS) assurance messages to pilots. A new airport surface detection radar (ASDE-3) will replace the older, lower performance radar (ASDE-2) and will also be installed at other qualifying airports. An automated weather observation capability will be implemented. Two new capabilities are scheduled for procurement during the last five year period, namely a beacon based airport surface surveillance system (TAGS) and, possibly, a special application terminal doppler weather radar.

The costs of these programs are estimated to total:

		FY-80 Dollars		Current Year Dollars	
		F&E	R,E&D	F&E	R,E&D
-	FY 1982-86	$ 430 M	$ 12 M	$ 615 M	$ 17 M
-	FY 1987-91	$ 585 M	$ 10 M	$1035 M	$ 20 M

(3) Airport Traffic Control Towers. The major efforts will be the building of new towers and the relocation of others. The addition of a remote maintenance monitoring capability will be in concert with an overall ATC program for improving maintenance while reducing costs through the widespread application of the remote maintenance monitoring concept.

The F&E costs of these programs are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 395 M	$ 565 M
-	FY 1987-91	$ 795 M	$1575 M

(4) Approach and Landing Systems. Additional ILS's will be procured to replace the older, obsolete systems and to provide service at additional runway ends. Other ILS's and associated improvements will be procured to improve services at those airports designated for upgrading. Efforts to improve approach and landing systems will involve the start of Microwave Landing System (MLS) operational implementation with FY 1983 funds. Wind shear detection capability will be expanded and the effort to install frangible towers for approach lights will continue.

In addition to the aforementioned terminal improvements, there will be improvements realized through the use of advanced avionics. The use of head-up displays (HUD's) may be implemented in air carrier and perhaps other aircraft dependent on the results of an R,E&D funded effort to explore the merits of such equipment. Increased safety during low visibility approaches and landings may be possible. The display of air traffic information to the pilot using ground surveillance data sent to the aircraft via DABS data link is also being explored. This latter program may have some impact on the F&E program in the last five year period but decisions in that regard still have to be made.

The costs of these programs are estimated to total:

	FY-80 Dollars		Current Year Dollars	
	F&E	R,E&D	F&E	R,E&D
- FY 1982-86	$ 510 M	$ 24 M	$ 710 M	$ 32 M
- FY 1987-91	$ 525 M	$ 31 M	$1050 M	$ 60 M

A listing of the improvement programs that will be made during both the first five years (FY 1982-1986) and the following five years (FY 1987-1991) is shown in Figure IV-2. All programs shown require an integrated and supportive developmental effort except for those identified by an asterisk. In those latter cases, the improvements will be attained by the purchase or relocation of facilities where development was completed with pre FY-1981 R,E&D funds or where facilities/equipment were available directly from industry without the need for FAA R,E&D programs. Programs are listed in two columns (1981-1986 and 1987-1991) according to the period when funds are required rather than when they will be completed. Programs shown in both columns indicate that funding will be required in both periods.

FIGURE IV-2
Summary of Improvements to Terminals
FY 1982-1991

	FY 1982 - 1986	FY 1987 - 1991

TRACON		- Computer Replacement:
		  - ARTS-IIIA
		  - ARTS-II
		  - TPX-42

	- Automate/Replace TPX-42* Facilities
	- Terminal Automation Improvements
	  - Mosaic NY TRACON Software
	  - Capability Expansion
	  - Upgrade ARTS-II, Conflict Alert Plus MSAW
	  - Full Digital ARTS Display
	  - TAB G Automatic Tracker
		- Terminal Automation Improvements
		  - Sequencing and Spacing ARTS III
		  - Display of Weather Information
		  - Full Digital Display
		  - TAB G Automatic Tracker
		  - Terminal Information Display System
		  - Integrated Flow Management

	- R-2508 Enhancements* - Expand Enhanced Target Generator - Power Conditioning ARTS-III* - Interface for Active BCAS (RBX) - Flight Data Input Output Equipment	
SUR-VEIL-LANCE	- Add Additional ASR Sites* - ASDE-3: Replace ASDE-2 Add Additional Sites - Replace Beacon Antennas* - Remote/Improve ASR Displays	- Install Airport Surveillance* Radars (ASR-9's) - Install DABS/ATARS - Add MTD and RMM to ASR-7/8's - Add Additional ASR Sites* - Terminal Automated Ground Control Systems (TAGS) - Digital Remoting To Towers* - Limited Range Radar

NOTE: All programs are integrated F&E and R,E&D programs except those designated by an asterisk, which indicates no supporting R,E&D is required.

	FY 1982 - 1986	FY 1987 - 1991
TOWER	- Establish*, Relocate*, Modernize Airport Traffic Control Towers, Including: Replace Recorders*	- Establish*, Relocate*, Modernize Airport Traffic Control Towers (A Continuing Program) - Radar Remote Digital Display For Satellite Towers
COMMUNICATIONS	- Terminal Voice Switching and Control - Replace Obsolete Equipment With Functionally Similar Equipment*	- Terminal Voice Switching and Control - Replace Obsolete Equipment With Functionally Similar Equipment* - Applications Processors For Automatic Sending of Messages Via DABS Data Link - Add RMM to Communication Facilities
APPROACH AND LANDING	- Initial MLS Sites - Commuter Airports Upgrade* - ILS*	- Continue MLS - Commuter Airports Upgrade* Continued - No further ILS Except Within Commuter Airport Upgrade Program*
	- ILS Replacement* - Localizer/Marker* - Wind Altimeter Voice Equipment - Upgrade ILS to CAT II* - Wind Shear Detection	- ILS Replacement* - Localizer/Marker*
	- Nonprecision Approach Aids* - Lighting Systems* - Establish/Upgrade* Runway Visual Range (RVR)	- Nonprecision Approach Aids* - Lighting Systems* - RVR Equipment*
	- Establish Visual Approach Slope Indicators* (VASI)	- VASI*
NAVIGATION	(Applies throughout ATC System — Not just terminal)	
	- Relocate/Establish VOR*	- Relocate/Establish VOR*
OTHER	- BCAS - Active - Head-Up Display (HUD) - Automated Weather Observation System	- BCAS - Full - Integrated Avionics Including Cockpit Display Traffic Information (CDTI) - Remote Maintenance Monitoring (Wide array of terminal equipments)

NOTE: All programs are integrated F&E and R,E&D programs except for those designated by an asterisk, which indicates no supporting R,E&D is required.

D. FLIGHT SERVICES. The principal programs of the FAA which support the provision of preflight and inflight services primarily to non air carrier pilots and air crews are related to or are part of the flight service station (FSS) automation and modernization program.

Flight Service Station (FSS). The FSS automation and modernization program is to be implemented in three phases each building on the previous phase. The first phase, Model 1, is to be deployed at 41 Level III FSS's. It provides the specialist with retrieval and display of weather and aeronautical data and flight plan entry and processing.

Model 2, full automation, is to be deployed at 61 FSS's located at airports which are major centers of general aviation activity. The specialist will have, in addition to the Model 1 capabilities, weather radar, weather graphics and additional aeronautical information and processing.

The Model 2 system has the capacity to handle the long-term flight service demand either from the specialist or directly from the pilot. It also provides software and interface to support direct user access to the system (Model 3).

The Research and Development program in Flight Service Stations is primarily oriented toward the development of Model 3. Model 3 has three major subdivisions:

- User Self-Briefing via computer terminals called Direct User Access Terminals (DUATS)

- Direct User Access via push button telephone
- Direct User Access via any telephone, using advanced applications of automatic voice recognition.

The costs of these programs are estimated to total:

	FY-80 Dollars		Current Year Dollars	
	F&E	R,E&D	F&E	R,E&D
- FY 1982-86	$ 320 M	$ 17 M	$ 425 M	$ 23 M
- FY 1987-91	NA 1/	$ 34 M	NA 1/	$ 68 M

The major programs involved in the FSS automation and modenization are shown in Figure IV-3.

1/ No estimate available.

FIGURE IV-3
Summary of Improvements To Flight Service Stations
FY 1982 - 1991

FY 1982-1986

- Flight Service Data Processing System (FSDPS), Automated Flight Service Station, (AFSS)

- MODEL 1 (1982 - 1983):
  - Automated Support to Specialist: Weather and Aeronautical Information Maintenance and Retrieval, Flight Plan Processing and Automated Alerts

- Digitized Weather Radar At 44 En Route Flight Advisory Service (EFA's)

- MODEL 2 (1983 - 1984):
  - Direct User Access to Weather Briefing and Flight Plan Filing
  - Selective Weather Retrieval
  - Improved Graphics and Multiple Weather Radar
  - Automated Support to Emergency Assistance

- AVIATION WEATHER PROCESSOR (AWP):
  - Centralized Maintenance of Weather And Aeronautical Information

FY 1987-1991

FSDPS/AFSS/AWP

- AWP/Weather Message Switching Center (WMSC) Consolidation
- Integrated Voice Response System (VRS)
- Consolidated Model 2, Model 3
- Color Graphics
- Pilot Access To Weather Flight Plan Filing Via DABS Data Link
- Aviation Weather System (AWES)

- Specialist Assisted VRS

E. TECHNICAL SUPPORT. Technical support includes updating the FAA aircraft fleet, associated avionics, and support equipment to provide flight inspection of navigation aids, flight training, research support and related activities. The funding of this program is by two separate appropriations: (1) Facilities and Equipment - F&E, and (2) Facilities, Engineering and Development - F,E&D. The basic difference between these appropriations is that the F&E is funded from the aviation trust fund and the F,E&D is funded from the general revenue operations appropriation.

The F&E funded program is discussed in Section (1) and the F,E&D in Section (2).

(1) Aircraft and Related Equipment - F&E.

a. Facilities Flight Inspection. A major function of the FAA aircraft fleet is certifying the performance of air navigation aids and instrument flight procedures supported by these navigation aids throughout much of the world.

b. Flight Training. Flight training is needed for flight inspectors and electronic technicians to acquire and maintain the skills necessary for the flight inspection program.

c. Research Support. FAA aircraft are used to support the FAA engineering and development program by testing new electronic aids, air traffic procedures, aircraft safety improvements, and communications and guidance equipments. Test bed aircraft are configured for rapid installation and removal of equipment being tested, and are equipped with specialized antennas, electrical power, and a variety of test equipment.

d. Aircraft Program. A major emphasis in the management of FAA aircraft is aviation fuel conservation. The FAA has established a goal to reduce its aviation fuel consumption by five to ten percent below the 1979 level. During the 1982-1991 period, the program covers the purchase of nine aircraft and one simulator plus the normal modifications and additions required for avionics. These planned acquisitions will permit the accomplishment of the agency's flight program with fuel efficient, high productivity aircraft assigned to the high utilization segment of this program, and less fuel efficient aircraft reassigned to low utilization programs. Those aircraft excess to agency needs will be phased out of service.

Another segment of the program is the start of a multiyear project to re-engine the Sabreliner aircraft with fuel efficient turbofan engines.

Major elements for the 1982-1986 period include:

- One multipurpose flight inspection aircraft
- Three special mission aircraft
- One research and development aircraft
- Four STOL aircraft
- Re-engine of seven Sabreliner aircraft
- Flight Inspection Trainer
- Install Wind Shear Detection and Avoidance System
- Install Beacon Collision Avoidance System

The plan for modification and purchase of avionics to support the existing Flight Inspection and R&D fleet reflects the need to continually update equipment as more efficient equipment is developed.

In the latter part of the 1980's it is anticipated that the older inefficient aircraft will be replaced with modern fuel efficient aircraft.

Major elements for the 1987-1991 period include:

- Re-engine of eight Sabreliners
- Replace Flight Inspection System
- Microwave Landing System (aircraft)
- Replace five Jet Commander aircraft
- Replace 2 Gulfstream aircraft
- ATARS

The F&E costs (1980 dollars) of these programs are estimated to total:

- FY 1982-1986 $ 75 M
- FY 1987-1991 $ 120 M

(2) Aircraft and Related Equipment - F,E&D.

a. Logistics. Aircraft support is required in Alaska to supply remote islands and areas with priority transportation and emergency rescue services; and in the contiguous U.S., support is required for the emergency transportation of aircraft engines and aircraft maintenance crews.

b. Flight Training. Training is necessary to enable FAA air carrier and general aviation inspectors to provide quality and standardization in issuing airman certificates and conducting surveillance checks of air carrier operations. Nonflight inspection aircraft and avionics are planned to be provided, improved or replaced to keep inspectors current in the latest technology and to maintain proficiency in their duties.

c. Evaluation, Currency, Transportation. FAA pilots, air carrier and general aviation inspectors, and agency operations specialists need to maintain their flying skills in FAA aircraft and a wide variety of rented aircraft and simulators. Also, there is a need to provide transportation for accident investigation teams, and for agency officials to evaluate the air traffic system and proposed airport projects.

d. Aircraft Program. The acquisition of a B-727 simulator approved in FY-1981 and the planned acquisition of a DC-9 simulator represent a major step in the reduction of aviation fuel in the flight training program during this period.

The acquisition of a multipurpose flight inspection aircraft under the F&E program will permit a reduction of one aircraft in the logistic fleet.

The evaluation, currency, and transportation element includes the acquisition of four light twin turboprop aircraft to support regional and Washington Headquarters requirements and the acquisition of 84 single engine aircraft to support requirements of the Flight Standards District Offices and the General Aviation District Offices.

In addition, the plan for modification and purchase of avionics to support the existing fleet reflects the need to continually update equipment as more efficient equipment is developed.

The F,E&D costs (1980 dollars) of these programs are estimated to total:

- FY 1982-86 $ 25 M
- FY 1987-91 $ 16 M

F. RESEARCH AND DEVELOPMENT. Included in this section is a brief description of R,E&D programs in support of the F&E ten year plan and the R,E&D programs not scheduled for implementation until after 1991. Those programs supporting the ten year plan (implementation prior to 1991) are described more fully in the En Route, Terminal, Flight Services and Technical Support sections of this chapter. Also, a complete description of program activities, major milestones and fiscal planning are contained in Appendices II and III, "Research, Engineering and Development."

(1) 01 1/ Systems Program. This program provides the overall systems engineering and guidance needed to plan and integrate efforts to progressively upgrade the National Airspace System. The scope of this program includes evaluation of the current ATC system performance; the determination of future performance requirements; the development of long-range research programs, requirements studies, and cost/benefit analyses; and the identification of potentially needed system changes.

The costs of this program are estimated to total:

	FY-80 Dollars	Current Year Dollars
- FY 1982-86	$ 98 M	$ 135 M
- FY 1987-91	$ 148 M	$ 294 M

1/ Specific notation for R,E&D programs.

(2) <u>02 Radar.</u> The basic objective of the radar Engineering and Development (E&D) program is to develop new primary radars and necessary improvements to existing primary radars. The capabilities of the systems that will be in operational use in the mid 1980's or under procurement at that time indicate that the main thrust of radar developmental efforts should be aimed at reducing future operation and maintenance costs and/or providing for new low cost supplemental systems. This includes possible consolidation of the features of both weather detection and assessment radars and aircraft detection and tracking radars into improved radars that will perform both functions, as well as the development of radars that can detect the presence of windshear and wake vortex along arrival and departure paths.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 2 M	$ 3 M
-	FY 1987-91	$ 36 M	$ 70 M

(3) <u>03 Beacon.</u> The objective of this program is to insure the availability of an improved beacon system to serve as the primary means of airspace surveillance and as the backbone of ATC automation. The specific goals for the FY 1982-91 time period include:

- En route Discrete Address Beacon System (DABS) capabilitity to reduce problems associated with the existing ATCRBS system and to provide improved accuracy.
- Air-ground-air data link to support other plans for increased automation of ATC functions and the automatic delivery of ATC messages.
- Improved aircraft separation assurance services.

- Traffic information for safe operations into uncontrolled airports that do not have manned control towers but are in need of ATC services.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 27 M	$ 35 M
-	FY 1987-91	$ 33 M	$ 65 M

(4) 04 Navigation. The goals of the R,E&D navigation program are to enhance aircraft navigational safety, improve en route/terminal capacity/efficiency, and improve cost-effectiveness of near-term and future navigation services. FAA near-term R,E&D activities will provide the basis for a recommendation to the Secretary of Transportation in 1982 or 1983 on the appropriate mix of navigation systems to meet common civil/military navigation requirements. During the 1983-1991 period supporting analysis will be undertaken to begin transition to the selected system or mix of navigation systems.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 33 M	$ 44 M
-	FY 1987-91	$ 47 M	$ 92 M

(5) 05 Beacon-Based Collision Avoidance System (BCAS). The principal objective of the BCAS program is to enhance the safety of air travel by reducing the potential for midair collision through the use of aircraft carried systems that will detect the presence of other aircraft

in the vicinity equipped with ATCRBS or DABS transponders and provide collision avoidance maneuver signals to the pilot in cases where a high collision risk develops.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 20 M	$ 25 M
-	FY 1987-91	$ 16 M	$ 31 M

(6) 06 Communications. The R,E&D objective is to develop a communications system for the transmission of voice and the distribution of data rapidly, accurately, reliably and economically in support of the future highly automated air traffic control system. The objective includes both air-ground and ground-ground voice and data communication.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 57 M	$ 75 M
-	FY 1987-91	$ 57 M	$ 110 M

(7) 07 Approach and Landing Systems. The goal of this program is to develop and support the implementation of the Microwave Landing System (MLS).

Another major program in this development area consists of exploring new ways of increasing crew performance and reducing collective avionics costs by assessing the impact of new avionics associated with ATC improvements. This effort will also explore the possibilities of improving crew performance by such programs as Heads-Up Displays (HUD's), the display of traffic information in the cockpit (CDTI) and the eventual integration of originally separate avionics.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 25 M	$ 32 M
-	FY 1987-91	$ 31 M	$ 60 M

(8) 08 Airports. This program will improve airport capacity, safety and efficiency to meet future traffic increases. Programs will result in improved airport pavement designs, increased airport safety, better airport layouts and development of wake vortex tracking system.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 28 M	$ 38 M
-	FY 1987-91	$ 30 M	$ 59 M

(9) 09 Airport/Landside. The goal of this program is to reduce negative impact of the environment, and identify potential solutions to airport ground access problems.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 4 M	$ 5 M
-	FY 1987-91	$ 5 M	$ 10 M

(10) 10 Oceanic. Currently inactive.

(11) 11 Central Flow Control. This provides the engineering and development support to upgrade the Central Flow Control Automation System. The major goals are to improve the efficiency of national

airspace system management and to reduce aircraft fuel consumption caused by airborne delays due to severe weather and unanticipated system overloads.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 5 M	$ 7 M
-	FY 1987-91	$ 15 M	$ 29 M

(12) 12 En Route Control. The objectives of this program are to increase safety, reduce en route delays and fuel consumption, expand system capacity and maximize controller productivity.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 95 M	$ 131 M
-	FY 1987-91	$ 75 M	$ 146 M

(13) 13 Flight Service Automation Program. This program is to provide automation capability to the present inefficient, maintenance intensive, overloaded manual flight service station facilities while maintaining the required high level of service to meet the ever increasing needs of users.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 17 M	$ 23 M
-	FY 1987-91	$ 34 M	$ 68 M

(14) 14 Terminal Tower Control. The objectives of this program are to provide the engineering of improvements to the existing terminal automation systems and the development of new system capabilities which will result in increased safety, improved controller productivity, and reduced fuel consumption of traffic in the terminal control areas. This program will also include replacements of the terminal computers to meet the long-term need of the terminal/tower environment.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	\$ 80 M	\$ 123 M
-	FY 1987-91	\$ 117 M	\$ 225 M

(15) 15 Aviation Weather Program. The Aviation Weather Program is aimed at progressively improving the timeliness and accuracy of weather information provided to all users of the national airspace system. The overall objectives are to reduce the frequency of weather related accidents and to increase both system capacity and fuel savings by reducing weather related delays.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	\$ 45 M	\$ 60 M
-	FY 1987-91	\$ 68 M	\$ 127 M

(16) 16 Technology. The technology program will evaluate the capabilities and applications of technological advancements to the present and future National Airspace System, especially in the areas of

advanced data processing and displays, sensor development and applications, computing, and human factors engineering. The ATC computer replacement program is also being accomplished under this activity.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 27 M	$ 325 M
-	FY 1987-91	$ 50 M	$ 113 M

(17) 17 Satellites. Currently inactive.

(18) 19 Aviation Medicine. This program is concerned with the analysis, assessment and improvement of the role of the human operator as part of the air traffic control (ATC) system in order to increase the efficiency, reliability and safety.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 5 M	$ 7 M
-	FY 1987-91	$ 5 M	$ 10 M

(19) 21 Support. This program provides technical support for solution of overall ATC system problems which do not fall logically into any one of the other development programs. The objectives are to identify requirements for overall ATC system improvements and to conduct analysis and development activities to accomplish objectives related to resolution of system interface problems, development and evaluation of ATC operational procedures, and support to air traffic controller training programs.

The costs of this program are estimated to total:

		FY-80 Dollars	Current Year Dollars
-	FY 1982-86	$ 9 M	$ 11 M
-	FY 1987-91	$ 8 M	$ 15 M

G. AIRPORTS. Before developing a legislative proposal for airport grants-in-aid after 1980, the FAA reviewed the record of the Airport Grants-In-Aid Program. It was found that the grant program, in conjunction with other measures, had significantly improved the safety, capacity and efficiency of the airport system. The airport system in 1979 accommodated about 100 million more passengers than in 1969, with lower average delays. Where major capacity development such as parallel runway construction had been undertaken, it was particularly effective in minimizing delays.

Consultation with members of the aviation community revealed that they were generally satisfied with the Airport Grants-In-Aid Program, but believed that higher funding levels were needed. This was particularly true in the area of reliever airport development. The grant program had set aside $15 million annually to help develop reliever general aviation airports that could attract light aircraft away from congested air carrier airports. The level of funding proved to be inadequate, and a backlog of requests for Federal aid to reliever airports accumulated. The immediate problem was alleviated by the satellite airport program in fiscal years 1979 and 1980, under which over $100 million in development aid and navaids was directed to these airports. A longer range solution was proposed in the form of the post 1980 primary hub concept, under which over $100 million a year would be set aside for the systematic development of reliever and commercial service airports in large metropolitan areas.

The concept was included in the Administration's proposed "Airport and Airway Improvement Act of 1979." Under the full proposal, $700 million in Federal aid would be provided for airport development grants in fiscal year 1981, and this would be increased by $50 million a year to $900 million in 1985. This level of funding would be consistent with the pattern of expenditures under the grant program and would continue the strong Federal presence in fostering airport development. It is noted that this proposed level is not adequate to fund all of the airport development that will be needed. In fact, when it is combined with local matching funds, it is about half as much as the airport development needs that are eligible for Federal aid. However, this level is considered adequate to meet the general objectives of the program, which are to foster airport development in a manner consistent with a national system plan, encourage the use of safe and efficient airport design standards, help implement safety and security development on a high priority basis, and ease the financial burden of sponsors of public airports.

H. PERSONNEL/MANPOWER. Personnel are required in the National Airspace System (NAS) to develop, establish, maintain and operate the air traffic control navigation, and related subsystems. The efficient accomplishment of these tasks requires a broad spectrum of occupational skills. These range from the highly technical, such as air traffic control and electronic maintenance, through the general administrative and managerial skills needed to conduct the business of a large Government agency.

FAA personnel requirements over the 1982-91 period are shown in Figure IV-4. These levels have been determined primarily through application of staffing standards to forecasts of aviation activity. They also take into consideration the additional personnel that will be required to operate and maintain the new facilities and equipment outlined in this plan. The level of funding required to support the staffing and programs is shown in Figure IV-5.

(1) Operations Personnel. Operations personnel are utilized for: (a) operation of the air traffic control system; (b) maintenance of airway facilities; (c) installation and materiel management, (d) administration of aviation standards program; (e) administration of medical programs, (f) development direction, (g) administration of the airports program, (h) operation of centralized training facility, management school and other training programs, (i) direction, staff and support to overall FAA mission, (j) administration of the air transportation security program, and (k) specialized engineering and development.

a. Air Traffic Control.

- En Route Control. En route control personnel are employed in Air Route Traffic Control Centers (ARTCC's) and are responsible for ensuring the separation of aircraft flying under Instrument Flight Rule (IFR) conditions by use of radar and air/ground communications.

- Terminal Control. Terminal control personnel are employed in Airport Traffic Control Towers (ATCT's) and Terminal Radar Control Facilities (TRACON's and TRACAB's). Their primary responsibility is to ensure the separation of aircraft arriving and departing airports over which the terminal facilities have jurisdiction.

- Flight Services. Specialists employed at Flight Service Stations (FSS's) provide a number of services to the aviation community. Among their major functions are air/ground communications, weather briefings, and associated flight information.

- Other. Specialists at the ATC Systems Command Center provide flow control services, military altitude reservations and airport reservations at quota airports. Specialists at the National Flight Data Center operate the Notice to Airmen and aeronautical information services. Specialists at the National Communications Center operate the communication switching systems. Specialists at regional and national headquarters offices provide policy development, directions, supervision and evaluation services.

b. Airway Facilities. The integrated network of air navigation, communications and air traffic control facilities comprising the National Airspace System is maintained by airway facilities personnel in the operational program. Maintenance operations and support services performed include equipment maintenance inspection, monitoring and technical control of facility performance for optimum reliability and system integrity.

c. Installation and Materiel. The procurement, distribution, inventory control and contract management aspects of the agency's supply support program are performed by logistics personnel. This activity also includes space administration management, leased services, standardization and product quality control as specified for airway facilities, central procurement operations, agency aircraft and avionics to meet the requirements of facility establishment, operation, modernization and disposal phases of the system life cycle.

d. Aviation Standards. Aviation Standards personnel administer the Flight Standards Regulatory and Aircraft field programs and the Civil Aviation Security field programs. This mission is to promote the safety of flight of civil aircraft in air commerce by assuring the airworthiness of aircraft; the competence of airmen; the adequacy of flight procedures and air operations; the prevention of unlawful acts in air commerce; and the in-flight inspection of civil and military air navigation aids. The office is also responsible for the management and maintenance of the FAA aircraft fleet.

e. Medical. Aviation medical personnel are required to insure the physical fitness of personnel in the National Airspace System by the promulgation and enforcement of physical examination procedures and medical certification programs. In support of this operation other essential elements requiring medical personnel are medical standards development and validation, aircraft accident medical investigation, preventive airman medical education and the operation of the aviation medical examiner system.

f. Development Direction. With the exclusion of medical research, a limited number of operations personnel are responsible for the planning, direction and evaluation of engineering and development activities.

g. Airports. In the administration of the airports program, personnel are needed to develop and publish the National Airport System Plan, to administer grants for airport planning and development and to provide engineering, advisory and control services. Airports personnel are further required to develop and enforce the Federal Aviation Regulations relating to airports and ensure that airports which require airport operating certificates meet these regulations.

h. Centralized Training. The FAA operates a centralized training facility at the FAA Academy in Oklahoma City, Oklahoma. It also operates a management training school and a wide variety of other training programs. The personnel associated with these programs are included in this category.

i. Direction, Staff and Support. These personnel provide direct administrative support to the overall FAA mission. They provide executive direction and management and administrative support including personnel, budget, accounting, planning, etc. These personnel also develop preparedness plans and direct preparedness programs to assure effective support of civil and military aviation in a national emergency.

(2) Facilities, Engineering and Development. These personnel develop data to support rulemaking decisions and develop certification standards and criteria to economically minimize negative environmental effects on the public. Aeromedical personnel identify and eliminate physical, psychological and physiological factors which could jeopardize flight safety.

(3) Research, Engineering and Development. To further advance the state-of-the-art in air traffic control, navigation, aviation weather, aircraft safety, aviation medicine, airport engineering, and provide new hardware to improve and modernize the National Airspace System, the FAA conducts an ongoing research, engineering and development program. Personnel are required to conduct and manage these activities, and oversee contract efforts. These activities are financed from the Airport/Airway Trust Fund.

(4) Facilities and Equipment. In a continuing program of improving and expanding the facilities and equipment used in the National Airspace System, personnel are required to accomplish a number of tasks related to this program. Primarily, F&E personnel are used for: (a) engineering services related to the construction and installation of F&E items, (b) fabrication/installation of new and improved equipment, (c) quality control (factory inspection) of F&E procurements to ensure their adherence to agency specifications, and (d) systems engineering support. These activities are financed from the Airport/Airway Trust Fund.

I. SUMMARY. This chapter has described the major resources needed to accomplish the system performance levels discussed in Chapter III. These resources in terms of the capital programs funded from the Trust Fund for F&E, Airport Grants-In-Aid and R,E&D cannot be accomplished without personnel and supporting funds appropriated from the General Fund. It is important to note that the personnel levels needed during the 1981-1991 period increase only marginally from the existing FY 1981 level. A slight increase in personnel is anticipated to staff new facilities such as Airport Traffic Control Towers installed to satisfy the needs generated by expanded aircraft activity. However, because of the installation of major automation improvements and investments in more efficient facilities and equipment, employee productivity is expected to increase to such a degree that only a limited number of additional employees are required. These personnel requirements for FY 1981, FY 1986 and FY 1991 are shown in Figure IV-4. The funding levels needed to support this level of staffing and the capital programs are shown in Figure IV-5.

FIGURE IV-4
Personnel Requirements
(Full Time Permanent Positions)

Positions	FY-1981 Allocation	Plannned FY-1986 Requirements	Planned FY-1991 Requirements
A. OPERATIONS			
Air Traffic	30,298	31,298	32,548
Airway Facilities 1/	12,677	11,584	11,330
Installation & Materiel	2,030	2,005	2,005
Aviation Standards	4,639	4,526	4,526
Medical	282	290	290
Development Direction	174	171	171
Airports	559	572	572
Centralized Training	1,032	980	980
Civil Aviation Security	284	272	272
Direction, Staff and Support	2,357	2,315	2,315
TOTAL OPERATIONS	54,332	54,013	55,009
B. FACILITIES, ENGINEERING AND DEVELOPMENT	151	151	151
C. RESEARCH, ENGINEERING AND DEVELOPMENT	769	769	769
D. FACILITIES AND EQUIPMENT	1,332	1,332	1,332
E. OPERATION AND MAINTENANCE, METROPOLITAN WASHINGTON AIRPORTS	826	826	826
F. AVIATION INSURANCE	2	2	2
TOTAL POSITIONS	57,412	57,093	58,089

1/ Airway Facilities includes the following:

	1981	1986	1991
- Field Maintenance	11,502	10,414	10,160
- Program Maintenance and Evaluation	1,175	1,170	1,170
TOTAL	12,677	11,584	11,330

FIGURE IV-5
Funding Requirements
(In Current Year Dollars)

Appropriation	FY-1981 Allocation ($ Millions)	Planned FY-1986 Requirements ($ Millions)	Planned FY-1991 2/ Requirements ($ Millions)
A. GENERAL FUND			
- Operations			
Air Traffic	$1,028	$1,428	$2,000
Airway Facilities	500	590	750
Installation & Materiel	264	507	980
Aviation Standards	181	217	270
Medical	11	14	20
Development Direction	7	10	15
Airports	22	35	50
Centralized Training	73	81	90
Civil Aviation Security	11	11	15
Direction, Staff & Support	147	205	290
	$2,244 1/	$3,098 1/	$4,480
- Facilities, Engineering and Development	24	28	30
- Operation and Maintenance, Metropolitan Washington Airports	29	41	50
- Construction, Washington Airports	18	61	80
TOTAL GENERAL FUND	$2,315	$3,228	$4,640
B. TRUST FUND			
- Research, Engineering and Development	85	227	300
- Facilities & Equipment	350	1,900	2,000
- Airports Grants-In-Aid	700	975	1,200
TOTAL TRUST FUND	$1,135	$3,102	$3,500
TOTAL APPROPRIATIONS	$3,450	$6,330	$8,140

1/ Includes FAA maintenance from Trust Fund.
2/ Assumes the same growth rate for the 1986-1991 period as that assumed for the 1981-1986 period.

GLOSSARY OF ABBREVIATIONS

AC	Air Carrier
ADAP	Airport Development Aid Program
AERA	Advanced En Route Automation
APEER	Aircraft Pilot Performance Enhancement and Error Reduction
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal Service
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
ASTC	Airport Surface Traffic Control
AT	Air Taxi
ATARS	Air Traffic Advisory and Resolution System
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
ATCS	Air Traffic Control System
ATCT	Airport Traffic Control Tower
AWES	Aviation Weather System
AWP	Aviation Weather Processor
BCAS	Beacon Collision Avoidance System
CDTI	Cockpit Display of Traffic Information
CERAP	Combined Center/Radar Approach Control
CMA	Control Message Automation
CPEER	Controller Performance Enhancement and Error Reduction
CS/T	Combined Station/Tower
DABS	Discrete Address Beacon System
DARC	Direct Access Radar Channel
DTE	Data Terminal Equipment
DUATS	Direct User Access Terminals
ETABS	Electronic Tabular Display Sub-System
EVSS	Electronic Voice Switching System
FAA	Federal Aviation Administration
FAAP	Federal Aid Airport Program
FDAD	Flight Data and Display
FDEP	Flight Data Entry and Printout System
FDIO	Flight Data Input/Output System
F&E	Facilities and Equipment
FSP	Flight Strip Printer
FSS	Flight Service Station

GA	General Aviation
GPS	Global Positioning System
HUD	Head-Up Display
IFM	Integrated Flow Management
IFR	Instrument Flight Rule
ILS	Instrument Landing System
LLWSAS	Low Level Wind Shear Alert System
MLS	Microwave Landing System
MSAW	Minimum Safe Altitude Warning
MTD	Moving Target Detector
NADIN	National Airspace Data Interchange Network
NAS	National Airspace System
NASP	National Airport System Plan
NEXRAD	Next Generation Weather Radar
RCAG	Remote Center Air-Ground Communications Facility
R&D	Research and Development
R,E&D	Research, Engineering and Development
RMM	Remote Maintenance Monitoring
RVR	Runway Visual Range
SAM	System Acquisition Management Process
STOL	Short Take-Off and Landing
TAGS	Terminal Automated Ground Surveillance System
TCA	Terminal Control Area
TIDS	Terminal Information Display System
TRACAB	Terminal Radar Approach Control in Tower Cab
TRACON	Terminal Radar Approach Control
TRSA	Terminal Radar Service Area
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rule
VOR	Very High Frequency Omnidirectional Range
VORTAC	Very High Frequency Omnidirectional Range (VOR) and Tactical Air Navigation (TACAN)
VSCS	Voice Switching and Control System
WMSC	Weather Message Switching Center
WVAS	Wake Vortex Avoidance System

APPENDIX I

Facilities and Equipment

Ten Year Plan

FY 1982 - 1991

This Appendix is a detailed program and fiscal listing of all the projects proposed for funding during the FY 1982-1991 period. This listing is consistent with the F&E program descriptions contained in Chapter IV. The analysis of the five alternative funding levels outlined in Chapter III varies slightly from this listing because of minor adjustments in the timing of a few capital projects.

Facilities and Equipment
Ten Year Plan
FY 1982-1991
(Constant 1980 Dollars in Millions)

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	Total FY 1982-1986	Total FY 1987-1991
1. Air Route Traffic Control Facilities							
a. Long Range Radar							
Establish LRRs	13.1					13.1	
Air Route Surveillance Radar-3 (ARSR-3) Beacon Remote Maintenance Monitoring (RMM)	13.1					13.1	
Alaskan Joint Use Minimally Attended Radar (MAR)	8.8					8.8	
Relocate/Improve Long Range Radar/Air Traffic Control Radar Beacon System (LRR/ATCRBS)	.7	6.5	1.3	1.3	1.3	11.1	13
Replace Long Range Radar (LRR)		40.0			149.0	189.0	222
Doppler Weather Radar				4.0	21.5	25.5	47
Enroute DABS/ATARS							250
b. Automation Equipment							
Direct Access Radar Channel (DARC) Enhancements	16.2	8.7	4.6			29.5	
Upgrade/Expand Central Flow Control		3.1		.2		3.3	31
Electronic Tabular Display Subsystem (E-TABS)					36.0	36.0	20
Helicopter Data Link							11
Automatic Weather Display							11

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
b. Automation Equipment (Continued)							
En Route Flight Data Systems	11.0					11.0	
Automation Improvements/Enhancements		9.0		3.0		12.0	27
Oceanic Automation and Display System		2.0	4.0			6.0	
Establish Radar Training Facilities at ARTCCs			15.0	7.5	7.5	30.0	
En Route Computer Replacement					393.0	393.0	914
c. Other Center Facilities							
Enhance National Airspace Data Interchange Network (NADIN)	5.1	10.0	3.0	3.8	19.7	41.6	
Establish Remote Center Air/Ground (RCAG) Facility Channels	2.2	2.0	2.0	2.0	2.0	10.2	14
Modernize/Improve Sectorization	1.2	1.7	1.7	1.7	1.7	8.0	9
RCAG Signal Control Equipment-Replacement	3.8	19.0	20.0	7.0		49.8	
Establish Plan View Displays (PVDs)		14.0				14.0	
System Replacement Other Vacuum Tube Amplifiers (ARTCC)		4.0	1.5	2.0	2.0	9.5	
Replace/Improve Communications		1.6	1.5	2.0	2.0	7.1	12
Center Building/Plant Modernization		.8	1.6	1.6		4.0	
Enroute VSCS							90

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
2. **Airport Traffic Control Facilities**							
a. **Terminal Area Radar**							
Replace Airport Surveillance Radar-4/5/6 (ASR-4/5/6)	$21.4		$9.0	$97.5		$127.9	138
Discrete Address Beacon System/ Automatic Traffic Advisory and Resolution Service (DABS/ATARS)	17.0				120.0	137.0	131
Moving Target Detector (MTD)					34.0	34.0	
Establish ASR	10.7	15.0	5.0	5.0	5.0	40.7	85
Replace Beacon Antennas	12.6					12.6	
Relocate/Improve ASR/Displays	4.2	3.0	5.0	4.0	2.0	18.2	20
Establish Airport Surface Detection Equipment-3 (ASDE-3)		35.7				35.7	
Replace ASDE-2			20.0			20.0	
Establish Digital Radar Remoting to Satellite Towers					3.8	3.8	
Limited Range Surveillance Radar (LSR)							150
DABS Uplink Application Processor							47
b. **Terminal Area Automation**							
Terminal Automation Improvements	5.1	11.5	13.0	36.0	36.0	101.6	100
Area 2508 Enhancements	1.2					1.2	
Automa.e TPX-42 Facilities		16.0	15.0			31.0	
Terminal Information Display System					18.0	18.0	36

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
b. Terminal Area Automation (Continued)							
Terminal Backup Display System							14
Digital Remoting - Satellite ATCT							33
Terminal Computer Replacement							598
Terminal Automated Ground Control System							20
Automated Airport Advisory System							75
Replace/Provide Flight Data Entry and Printout System (FDEP) with FDIO	$3.9	$3.2				$7.1	
Expand Enhanced Target Generator (ETG) Labs			6.0	6.0	6.0	18.0	
c. Other Tower Facilities							
Establish Airport Traffic Control Tower (ATCT)	1.5	10.6	2.8	2.8	2.8	20.5	25
Relocate ATCT	33.6	50.0	60.0	50.0	60.0	253.6	250
Modernize ATCT		10.0	10.0	10.0	10.0	40.0	57
Replace Communication Equipment	11.9	17.0	24.9	10.1		63.9	
Remote Maintenance Monitors		10.0	15.0	15.0	15.0	55.0	370
Voice Switching and Control System			15.0	15.0		30.0	170
Replace Recorders			15.0	10.0		25.0	92
Power Conditioning System-Automated Radar Terminal System III (ARTS III)			7.0	7.0	7.0	21.0	
Automated Weather Observation Equipment	4.0	1.0	1.0	15.0	15.0	36.0	58

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
3. **Flight Service Facilities**							
a. **Flight Service Station**							
Flight Service Station (FSS) Modernization (Automation)	$27.6	$27.5	$24.2	$19.0		$98.3	
FSS Buildings	19.8	19.3	18.4	17.5	16.7	91.7	
FSS Consolidation		12.3	17.6	18.1	18.7	66.7	
Replace National Communications Center (NATCOM)	17.8					17.8	
Modernize/Improve FSS Facilities	2.4	1.7	1.7	1.7	1.7	9.2	9
Emergency Communications	4.2					4.2	
En Route Flight Advisory Service (EFAS) Weather Radar/Communications		2.4	2.2			4.6	
Direction Finder (DF) Replacement			25.0			25.0	
Teletype replacement							40

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
4. Air Navigation Facilities							
a. VORTAC							
Establish/Replace Very High Frequency Omni-Directional Radio Range (VOR)/VOR-Distance Measuring Equipment (DME) VOR with Tactical Air Navigation Equipment (VORTAC)	14.7	15.5	7.7	7.7	7.7	53.3	61
Relocate/Improve VOR	2.1		1.0	1.0	1.0	5.1	7
b. Low and Medium Frequency Facilities							
Establish Nondirectional Beacon (NDB)	.8	.8	.8	.8	.8	4.0	5
c. Instrument and Visual Landing Systems							
Establish Instrument Landing System (ILS)	18.9	13.0	11.0			42.9	
Satellite Airport Program	11.0					11.0	
Microwave Landing System (MLS)		15.7		65.0	65.0	147	390
Commuter Airports Program		16.2	18.7	19.6	18.7	73.2	
Establish ILS		(9.8)	(10.7)	(11.6)	(10.7)		
Establish Visual Approach Slope Indicators (VASI)		(.8)	(1.0)	(1.0)	(1.0)		
Establish Runway End Identification Lights (REIL)		(1.0)	(1.3)	(1.3)	(1.3)		
Establish Automated Low-Cost Weather Observation System (ALWOS)		(4.6)	(5.7)	(5.7)	(5.7)		

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
c. Instrument and Visual Landing Systems (Continued							
ILS Replacement	$8.4	$27.4	$24.2	$20.8		$80.8	
Establish Upgrade Localizer/Marker (LOC/MKR)	5.7	5.5	7.3			18.5	
Establish Wind Altimeter Voice Equipment (WAVE)	1.2	3.5	2.6	2.6	2.0	11.9	
Upgrade ILSs to Cateogry II Standards	3.0					3.0	
Establish Category II/III ILS		2.0	.6	2.0	2.0	6.6	
Establish Low Level Wind Shear Alert System (LLWSAS)	5.6	3.5				9.1	
Establish Nonprecision Approach Aids	4.2	4.0	4.0	4.0	4.0	20.2	29
Retrofit Medium Intensity Approach Light System with Runway Alignment Indicator Lights (MALSR) with Threshold Lights	1.1	.9				2.0	
Frangible Towers (Approach Light System (ALS)/MALSR)	7.1	15.3	15.3	15.3	15.3	68.3	15
Establish Omni-Directional Approach Light System (ODALS)	1.0	1.6	1.6	1.6	1.6	7.4	10
Establish/Add Medium Intensity Approach Light System with Runway Alignment Indicator Lights		.7	.7	.7	.7	2.8	5

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
c. Instrument and Visual Landing Systems (Continued)							
Establish/Upgrade Runway Visual Range (RVR) Equipment	$1.9	$2.0	$2.2	$2.3	$2.4	$10.8	29
Establish/Convert Runway End Identification Lights (REIL)	.8	1.3	2.0	2.0	1.0	7.1	20
Establish Visual Approach Slope Indicators (VASI)	1.0	2.6	3.6	3.6	3.6	14.4	21
Improve Navigation/Landing Aids	3.4	1.8	1.0	1.0		7.2	9
d. Housing, Utilities, and Miscellaneous Facilities							
Utilities and Miscellaneous							
Acquire Land	3.4	3.4	3.4	3.4	3.4	17.0	47
Local Projects/Teletypewriter Relocates/ Emergency Restorations	2.7	2.0	2.0	2.0	2.0	10.7	14
Replace/Improve/Relocate Modernize Miscellaneous Facilities/Equipment	2.0	2.0	2.0	2.0	2.0	10.0	33
In-Service Engineering	10.2	10.0	10.0	10.0	10.0	50.2	72
Provide Uninterrupted Power Transfer	1.1					1.1	
Establish Tramway	2.0					2.0	
Modernize Unmanned Facilities		4.5	5.3	5.6	3.8	19.2	
Provide Energy Improvements			4.0	4.0	4.0	12.0	22

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TOTAL FY 1982-1986	TOTAL FY 1987-1991
e. Aircraft and Related Equipment							
Procure/Replace Aircraft and Avionics Equipment	$18.9	$16.4	$14.3	$13.0	$12.6	$75.7	$118
f. Development, Test, and Evaluation Facilities							
Replace/Modernize/Improve FAA Technical Center	4.1	7.5	7.5	7.5	7.5	34.1	38
FAA Technical Center Lease	3.7	3.7	3.7	5.1	5.1	21.3	26
Structures and Equipment FAA Technical Center Improvement Program		4.2	10.0		10.0	24.2	
TOTAL	$414.1	$555.6	$535.5	$578.4	$1193.6	$3277.2	$5160

APPENDIX II

Research, Engineering and Development Program Descriptions For The Period

FY 1982 - 1991

APPENDIX II

Research, Engineering and Development

This appendix describes the R,E&D activities in support of the National Aviation System for the ten year period 1982 through 1991. Included herein is a brief description of R,E&D programs in support of the F&E ten year plan and the R,E&D programs not scheduled for implementation until after 1991. A listing of programs supporting the Ten Year F&E Plan appears in Chapter IV. All financial information contained in this appendix reflects current year dollars. The index of deflators obtained from Wharton were used as a basis for obtaining the current year dollars.

1. PROGRAM 01 - SYSTEMS

OBJECTIVES/GOALS: This program provides the overall systems engineering and guidance needed to plan and integrate efforts to progressively upgrade the National Airspace System. The scope of this program includes evaluation of the current ATC system performance, the determination of future performance requirements, the development of long-range research programs, requirements studies, cost/benefit analyses, and the identification of potentially needed system changes.

FY 1982-87 Support of F&E 10 Year Plan

During this time period, a wide variety of analytical activity will be undertaken with the intent of resolving critical National Airspace System issues. The following examples are not all inclusive:

- Evaluate the adequacy of present separation standards in en route airspace.
- Experimentation to address the issue of acceptable levels of automation, man-machine roles, and controller-supervision roles.
- Analysis of human factors impact of various advanced cockpit systems.
- Analysis of navigation requirements to be used as the basis for decision on future navigation system configuration.
- Determine NAVSTAR/GPS capability and system integration for civil aviation.

FY 1987-91 R,E&D Programs

During this time period, the principal studies will include the following:

- Automated Air Traffic Planning and Control

This effort is a major FAA feasibility study and demonstration of automation of the air traffic control decisionmaking process. If the concept of "AERA" (Automated En Route ATC), proves feasible this work will provide major increases in controller productivity and will permit a higher level of flexibility of aircraft operations than the current system permits. The data processing system will perform routine tasks involved in generation of clearances and resolution of conflicts, allowing the controller to devote this attention to exception handling, emergency situations, and ATC system management duties.

It is expected that the automated planning and control system -- an extremely difficult technology problem -- would enter full operational service after the computer replacement program is well along (in the 1990-2000 time frame). The system will be modular and will probably begin by providing tools to permit controllers to better visualize complex traffic situations and to permit adaptive airspace utilization with adaptive rules. It is expected that this system will build upon elements of the Integrated Flow Management Program.

Other advanced concepts to be explored and developed are:

- Automated Mixed Profile - Determining the most efficient utilization of runway and approach configuration to accommodate an extreme mixture of aircraft types such as general aviation, wide body jets, STOL aircraft and helicopters.

- Electronic Flight Rules (EFR) - Develop a new concept whereby a certain level of protection might be achieved by participating aircraft without requiring full participation in the ATC system.

- Cockpit Display of Traffic Information (CDTI) - An effort to explore the capabilities and limitations of CDTI systems for EFR functions as well as for other functions.

- Satellite System Exploration - An effort to explore the beneficial applications of satellite technology to oceanic applications. A result of this study will address the requirements for potential satellite utilization for domestic communications and ATC surveillance.

- Computer Aided Reasoning (Artificial Intelligence) - An effort to expand the latest scientific exploration of melding the human thought processes to computer technology so that computers can be built with the capability to reason and to learn. Specific applications are for both aircraft cockpits and in the ATC system to permit optimum interaction between man and machine.

FISCAL PLAN

FY 82-86	FY 87-91
134,852	293,608

2. PROGRAM 02 - RADAR

OBJECTIVES/GOALS: The basic objective of the radar E&D program is to develop new primary radars and improvements to existing primary radars where such improvement are warranted in support of the FAA mission. The main thrust of the radar developmental efforts should be aimed at reducing future O&M costs and providing for new low cost supplemental systems. This includes the possible consolidation of the features of weather detection and assessment radars and the features of aircraft detection and tracking into systems that will perform both functions as well or better than separate systems. Also included in the development of radars that can detect the presence of windshear along runway approach and departure paths. The following are the more specific goals for the FY 1986-90 effort.

FY 1982-86 Support of F&E 10 Year Plan

Separate weather detection radars will be introduced as a result of the NEXRAD program and the development of a shorter range weather detection system as described in Program 15.

FY 1986-91 R,E&D Programs

The future radar development opportunities lie in developing systems for special applications, new systems that offer the potential for reducing costs, and engineering to improve the performance of systems in operational use.

FAA in-house studies will be made during the FY 1982-86 time frame to explore the pros and cons of new initiatives such as follows:

- An airport radar to detect windshear along runway approach and departure paths.
- A combined aircraft/weather detection system that could provide improved performance in both areas at lower costs than separate ASR's and weather radars in terminal areas.

A low level of funding has been included for the development and test of components such as phased array multiple beam antennas, improved algorithms for processing radar data, processors, receivers, etc.

FISCAL PLAN

FY 82-86	FY 87-91
3,013	69,680

3. PROGRAM 03 - BEACON

OBJECTIVES/GOALS: The objective of this program is to support the implementation of an improved beacon system to provide the foundation for advanced levels of ATC automation. The specific goals for the FY 1982-91 time period include:

- Improved beacon (secondary radar) surveillance capability to reduce problems associated with the existing ATCRBS system and to provide improved surveillance accuracy.
- Improved aircraft separation assurance services.
- Traffic information for safe operations into uncontrolled airports that do not have manned control towers but are in need of ATC services.

FY 1982-86 Support of F&E 10 Year Plan

A major part of the effort needed to realize the first three of the above goals will be based on the development, test and preparation of procurement data for the Discrete Address Beacon System (DABS) and the colocated and integrated Automatic Traffic Advisory and Resolution Services (ATARS). Follow on activities during FY 1982-86 will include:

- The development of a version of DABS specifically suited for remotely located, unmanned en route surveillance sites. Special emphasis will be given to remote maintenance monitoring, and high reliability to assure operations without scheduled maintenance for long periods of time.
- ATARS developmental efforts will continue through the period to improve the original alogrithms and to provide new capabilities.
- Methods, procedures and tools will be developed to assist in site adaptation and operational evaluations.

FY 1986-91 R,E&D Program

Major activities during this time period will include feasibility studies and development programs for:

- Support ATARS testing, evaluation and implementation.
- Enhanced ATARS development.
- Automated Traffic Advisory System, beacon based (ATS)

FISCAL PLAN

FY 82-86	FY 87-91
34,543	64,841

4. PROGRAM 04 - NAVIGATION

OBJECTIVES/GOALS: FAA's navigation program is to enhance aircraft navigational safety, improve en route/terminal capacity efficiency, and improve cost-effectiveness of near-term and future navigation services.

FY 1982-86 Support of F&E 10 Year Plan

Support development, test and analysis of near-term air navigation systems/services.

Provide the basis for a recommendation to the Department of Transportation in 1982 on the appropriate system mix to meet common civil/military navigation requirements.

Support the transition to the selected system/mix in the FY-83 to FY-86 time frame.

FY 1987-91 R,E&D Programs

Support the Federal Radio-Navigation Plan (FRP) which provides the framework for selecting a suitable mix of systems to meet user navigational needs in the post 1995 time frame and which provides a means to prevent a proliferation of navigation systems.

Omega/VLF Signal Simulator Final Report
GPS Flight Evaluation Final Report
GPS Prototype Low-Cost Receiver Final Report
GPS Helicopter Evaluation Report
Recommended Revision to TERPS for Helicopters
Advanced Helicopter Cockpit Display Evaluation Report
Differential LORAN-C System Final Report
GPS Flight Inspection System Final Report

FISCAL PLAN

FY 82-86	FY 87-91
44,103	92,279

5. PROGRAM 05 - AIRCRAFT SEPARATION ASSURANCE

OBJECTIVES/GOALS: The principal objective of the BCAS program is to enhance the safety of air travel by reducing the potential for midair collision through the use of aircraft carried systems that will detect the presence of other aircraft in the vicinity equipped with ATCRBS or DABS transponders and provide collision avoidance maneuver signals to the pilot in cases where a high collision risk develops.

FY 1982-86 Support of F&E 10 Year Plan

- Conduct experimental unit testing of Active BCAS transponders
- Analyze industry unit testing of Active BCAS transponders
- Conduct experimental unit testing of Full BCAS units
- Publish final report of Full BCAS testing
- Issue BCAS National Standard

FY 1987-91 R,E&D Programs

- Support Full BCAS operational testing and evaluation.

FISCAL PLAN

FY 82-86	FY 87-91
24,900	31,452

6. PROGRAM 06 - COMMUNICATIONS

OBJECTIVES/GOALS: Develop a communication system for the transmission and distribution of voice and data rapidly, accurately, reliably and economically in support of the future highly automated air traffic control system. The objective includes both air-ground and ground-ground voice and data communications.

FY 1982-86 Support of F&E 10 Year Plan

Replacement of the air-ground and ground-ground voice communication system with an integrated modern voice communication system. Specific installation requirements for FSS, tone channeling equipment replacement, ATCT and en route centers will be developed.

Data communications improvements include enhancements to NADIN to support FSS Automation, flight data input/output (FDIO) implementation and support for remote maintenance monitoring.

FY 1987-91 R,E&D Programs

Principal programs during this time frame include:

- NADIN Enhancements
- Support the data requirements for the ATC computer replacement program.
- Support the utilization of DABS Data Link to improve ground-air-ground communications and data transfer.
- Support the distribution of hazardous weather information to pilots and controllers (including NEXRAD data requirements).
- Support the communications requirements of other DOT model agencies, e.g., Coast Guard, NHTSA.
- Integration of voice and data communications networks.

FISCAL PLAN

FY 82-86	FY 87-91
75,131	109,673

7. PROGRAM 07 - APPROACH AND LANDING SYSTEMS

OBJECTIVES/GOALS: Develop and support the implementation of the Microwave Landing System (MLS).

Explore new ways of increasing crew performance and perhaps reducing collective avionics costs by assessing the impact of new avionics associated with new ATC improvements in crew performance, exploring the possibilities of improving crew performance by such things as Head-Up Displays (HUD), the display of traffic information in the cockpit (CDTI) and the eventual integration of avionics which, originally, will have been implemented separately at the time of the implementation of each new ATC capability requiring the display of information in the cockpit.

FY 1982-86 Support of F&E 10 Year Plan

The operational evaluation of various versions of head-up displays will be completed during the 1982-1984 period and certification criteria will be developed for dual HUD operations and for an Advanced HUD.

Study the effects of the impact of the planned ATC systems on aircraft operations, on coordination of flight deck information, and/or operational concepts. Associated studies of pilot factors will be required to provide inputs to an assessment as to what should be done to best accommodate all of the new capabilities in a cockpit instrumentation.

The MLS STEP program in FY-82 will include the purchase of approximately 20 airborne systems to expand user participation. Operational evaluation will continue through FY-83.

FY 1987-91 R,E&D Programs

Work will be started in the FY-86-87 time period to extend the MLS capabilities in the terminal areas and to refine designs to reflect advances in technology.

Various approaches for improving the coordination of flight deck information will be undertaken, including the development of a Computer Aided Decisionmaking (CADM) system to improve flight operational safety.

Studies of the man/machine interface and human engineering will be undertaken in relation to the expected evolution of the cockpit display of information.

Specific developments will be undertaken to develop new avionics to integrate and consolidate the presentation of ATC related information including the incorporation of the cockpit display of traffic information transmitted from the ATC system to the aircraft via data link.

FISCAL PLAN

FY 82-86	FY 87-91
31,932	60,259

8. PROGRAM 08 - AIRPORTS

OBJECTIVES/GOALS: Improve airport capacity, safety and efficiency to meet future traffic increases.

FY 1982-86 Support of F&E and ADAP 10 Year Plan

Development of airport safety improvements including new lighting configurations, visual aids, skid resistant pavements and crash-fire-rescue equipment.

Develop cost-effective design guidelines, construction techniques, maintenance procedures and new materials, and reduced construction methods for runway strengthening.

Development of guidelines for providing for accommodations in airport terminal buildings for elderly and handicapped persons.

Study energy efficient installations for runway and approach lighting and other airport facilities.

Increased airport capacity through minimization of the aircraft trailing wake vortex effect in the terminal airspace. Testing and evaluating pavements to determine useful life and provide cost effective rehabilitation alternatives. Although some systems are presently available they are time consuming and require substantial runway downtime.

Developing better methods for designing pavements in a freeze-thaw environment, the techniques of recycling, rubber removal and design for substantial higher traffic flows.

Assistance for Elderly and Handicapped Travelers.

FY 1987-91 R,E&D Programs

Long-range programs include developing visual guidance systems for helicopter and STOL operations under varying IFR weather conditions.

Major research will continue on improving the skid resistant characteristics of pavements new concepts such as a "percussive" groove and evaluation new surface texturing applications will be considered.

New cost-efficient systems to provide dry or ice and snow free pavements will be analyzed. Such a project would consider new types of removal equipment, surface and subsurface drainage and pavement heating elements.

Research directed toward improving CFR equipment response time through improvements to hardware and aircraft disaster/emergency planning guidelines will be initiated as a long-range effort.

Longer term pavement work will include the development, test and evaluation of new pavement technology.

Investigate the feasibility of ground-based wake vortex avoidance/advisory systems and aerodynamic alleviation, and develop an active tracker to assess strength and movement of wake vortices, and evaluate the potential hazard.

FISCAL PLAN

FY 82-86	FY 87-91
37,540	59,082

9. PROGRAM 09 - AIRPORT/LANDSIDE

OBJECTIVES/GOALS: Reduce negative impact of landside restrictions and identify potential solutions to airport ground access problems.

FY 1982-86 Support of F&E 10 Year Plan

This program addresses the major factors in landside restrictions, the development of practical measures of landside capacity and, after analysis, recommendation of improvement measures to the aviation community.

FISCAL PLAN

FY 82-86	FY 87-91
5,121	9,847

10. PROGRAM 11 - CENTRAL FLOW CONTROL

OBJECTIVES/GOALS: This provides the engineering and development support to upgrade the Central Flow Control Automation System. The major goals are to improve the efficiency of national airspace system management and to reduce aircraft fuel consumption caused by airborne delays due to severe weather and unanticipated system overloads.

FY 1982-86 Support of F&E 10 Year Plan

The system design concept for the en route computer replacement is such that it should be adaptable to meet the needs of the future central flow control system. R,E&D activity during this time period will be to analyze the hardware and software architecture proposes for en route computer replacement to determine their capability to accommodate the flow control functions. Implementation of a replacment for the central flow control computer will probably occur after all en route, terminal and display processor replacement has begun.

FY 1987-91 R,E&D Programs

The R,E&D activity during this period will include requirement analysis, design and development of a replacement for a system consistent with the guidelines of the integrated flow management — the central flow control portion of the integrated traffic flow management effort.

FISCAL PLAN

FY 82-86	FY 87-91
6,829	29,005

11. PROGRAM 12 - EN ROUTE CONTROL

OBJECTIVES/GOALS: The objectives of this program are to increase safety, reduce en route delays and fuel consumption, expand system capacity and maximize controller productivity. The specific goals for the FY 1981-91 time period are:

FY 1982-86 Support of F&E 10 Year Plan

Electronic Tabular Display System (ETABS)
En Route ATC Computer Replacement
Conflict Resolution Advisories
En Route Metering
En Route Metering Enhancements
Mode C Intruder and Conflict Alert Improvements
DABS Processing Improvements
DABS DARC Interface
DABS and ATARS Interface
Sector Suite Development

Implementation Dates

The products of the en route development program will be added to the operational system incrementally after thorough test and evaluation at the FAA Technical Center has proven the value of performance improvements. ETABS and En Route Metering, and initial En Route Software for operation with DABS and ATARS will be ready for implementation decisions during the 1980's. Implementation of the computer replacement system is not expected until after completion of the prototype system development in the late 1980's.

FY 1987-91 R,E&D Programs

During the FY 1986-91 time period the en route R,E&D programs will focus on two major goals:

- Higher levels of automated assistance to the controller.
- Improved flow management in en route airspace and into terminals.

The experimental Automated En Route ATC (AERA) facility has demonstrated the feasibility of automatically operating conflict free clearances for 10 to 20 minutes into the future. The AERA concept will be progressively expanded in functional capability with discrete implementable packages becoming available during the late 1980's. The AERA concept includes automated planning and coordination for direct route flights, control message automation (CMA) which will interface en route control positions with data link, greater productivity per controller by converting routine tasks to computer processes, and fewer traffic control errors.

Traffic flow management for en route ATC includes features such as determination of optimum fuel paths and profiles and advanced en route metering.

FISCAL PLAN

FY 82-86	FY 87-91
131,055	145,696

12. PROGRAM 13 - FLIGHT SERVICE AUTOMATION PROGRAM

OBJECTIVES/GOALS: This program is to support the F&E effort to provide automation capability for the present inefficient, maintenance intensive, overloaded manual flight service station facilities while maintaining the required high level of service to meet the ever increasing number of users.

FY 1982-86 Support of F&E 10 Year Plan

By 1986, R&D activities will have brought the FSS modernization program to the point that Model 2 full automation will have been installed and commissioned in about 25 flight service stations. The Model 1, limited automation, equipment which will be operational at

41 Level III FSS's, refurbished and redeployed with future Model 2 systems. The Model 2 system will be completely installed at all 61 Automated Flight Service Stations by 1988. Model 2 provides the specialist at his position with retrieval and display of weather and aeronautical data, flight plan entry and processing and weather radar and graphics.

The Model 3 Voice Response System will be operational in the 25 Automated Flight Service Stations and will be implemented with the remaining Model 2 systems. The pilot will be able to access the weather data base directly using a number of different low cost home computer terminals. Fixed base operators and others owning more sophisticated terminals will be able to access additional, more sophisticated, weather graphics.

FY 1987-91 R,E&D Programs

Improvements to the system software to accommodate new direct access devices and to obtain weather and aeronautical information in less time and at a lower cost than initially possible.

The capability of processing and disseminating to the flight service specialist and the pilot more "real-time" weather information such as three to four minute old satellite provided graphics and improved weather radar.

Improved specialist operations such as weather and aeronautical information formated especially for the aviation oriented user, improved operational procedures and automatic direction finding readouts.

The integration of new weather products such as Automatic Route Forecast with the Flight Service Automation System (FSAS) and the integration of new systems with the FSAS, for example, the Center Weather Service Unit System, Weather Message Switching System, and in 9020 Replacement System.

FISCAL PLAN

FY 82-86	FY 87-91
22,881	68,244

13. PROGRAM 04 - TERMINAL TOWER CONTROL

OBJECTIVES/GOALS: The objectives of this program are to provide the engineering of Improvements to the existing terminal automation systems and the development of new system capabilities which will result in increased safety, improved controller productivity, and reduced fuel consumption of traffic in the terminal control aeas.

FY 1981-86 Support of F&E 10 Year Plan

- ARTS III enhancements (beacon tracking, conflict alert, and minimum safe altitude warning).
- Terminal Information Display System (TIDS) for more efficient flight data handling and consolidation of displays associated with the status of airport communications, navigation and surveillance facilities.
- Terminal ATC computer replacement (which will be tailored after the en route ATC computer replacement).
- Full Digital ARTS Display (FDAD) for ARTS II and III.
- Tower Automated Ground Surveillance System (TAGS) to provide alpha numeric tags for airport surface displays in tower cabs as well as intersection conflict alerting.
- Airport Surface Detection Equipment (ASDE) which will provide radar surveillance of all ground traffic at high density airports for use in adverse weather conditions.

Implementation Dates

Implementation decisions are pending for the major products recently completed; namely, ASDE-3, the radar remoting capability with tower cab digital displays evaluated at Tampa-Sarasota, and the visual confirmation system for voice take-off clearance. Technical data packages for the Terminal Information Display System and Full-Digital ARTS Displays will be available for implementation decisions in FY-1982. Implementation decisions on the other programs will be made after project completion in later years.

FY 1987-91 R,E&D Programs

The principal goals that will focus the R,E&D effort during the FY 1986-91 time period include the development of technical data packages (TDP's) for an all digital ARTS II and ARTS III and the development of the advanced terminal sequencing and spacing software which will be operable in a multiple active runway environment and be interfaced with the Wave Vortex Advisory System and advanced en route metering.

A major goal for this time period will be to develop a computer system suitable for replacing the ARTS II and ARTS III computer hardware and software.

A major project of this program is Integrated Traffic Flow Management (IFM). This effort is intended to draw together in an integrated fashion a variety of systems and tools to permit aircraft to operate at their own highest level of efficiency, while maintaining safe and efficient system wide operation and making best use of airway and airport system resources. It will be an integration of aircraft systems, the National Central Flow Control System, en route metering, terminal flow planning and control aids, sensors and systems to allow best use of the airport and runway resources. While accommodating the expanded use of flight management computers incorporating 3D and 4D RNAV capability. This will allow all equipped participants to use optimum fuel utilization flight paths.

IFM will facilitate staged and orderly implementation of the various flow planning system elements, and take into full account new operational practices in the ATC system. Early products will be an enhanced en route metering system (currently under development), a runway configuration management system (development of which for one airport is expected to be completed in early FY-82), and terminal sequencing and spacing aids for controllers (in FY-83 or FY-84). Full implementation of an integrated traffic flow management system can be projected for FY-92.

FISCAL PLAN

FY 82-86	FY 87-91
122,622	225,432

14. PROGRAM 15 - AVIATION WEATHER PROGRAM

OBJECTIVES/GOALS: The Aviation Weather Program is aimed at progressively improving the timeliness and accuracy of weather information provided to all users of the national airspace system. The overall objectives are to reduce the frequency of weather related accidents and to increase both system capacity and fuel savings by reducing weather related delays.

FY 1982-86 Support of F&E 10 Year Plan

- Semi and fully automated surface weather observation stations.
- Center Weather Service Unit (CWSU) enhancements.
- Enhancement of the Flight Service Data Processing Systems (FSDPS) in each ARTCC to include an expanded weather data base and to support the CWSU's.
- Enhancement of the Electronic Tabular Display System (ETABS) and the Terminal Information Display System (TIPS) to provide for display of weather information to air traffic controllers.
- Display of weather radar data on existing or planned radar plan view displays.
- Weather radar using Doppler technology, both as part of a joint DOC, DOD and DOT program (NEXRAD) and for site specific FAA requirements at some terminal locations.

FY 1987-91 R,E&D Programs

During the FY 1987-91 time period the E&D program will emphasize the application of new technology to all major parts of the aviation weather system. The specific programs are:

- Full automation of surface weather observations.
- Further development of ground based and airborne sensors for determining atmospheric liquid water content and cloud drop size distribution to improve icing forecasts.

- Upgrade the capability of signature recognition of convective turbulence, wind shear and other hazardous weather conditions through improved processing of the output doppler radar sensors.
- Define the CWSU interfaces with both the en route and terminal ATC replacement automation systems.
- Continue the effort to more effectively detect clear air (CAT) and convective turbulence by airborne sensors.

FISCAL PLAN

FY 82-86	FY 87-91
60,038	126,520

15. PROGRAM 16 - TECHNOLOGY

OBJECTIVES/GOALS: Evaluate the capabilities and applications of technological advancements to the present and future National Airspace System, especially in the areas of advanced data processing and displays, sensor development and applications, computing, and human factors engineering.

FY 1982-86 Support of F&E 10 Year Plan

The technology program is designed to provide the latest state-of-the-art technology to system development. Included in this portion of the effort is advanced system modeling, workload determinates, and techniques to evaluate advanced hardware and software for applications in replacing present computers and automatic sensing equipment.

FY 1987-91 R,E&D Programs

Specific technological advances will be examined for applications of advanced LSI development and applications to avionics equipment, low cost avionics for GA applications and for LSI applications relating to reducing requirements for final avionics.

FISCAL PLAN

FY 82-86	FY 87-91
324,680	133,466

16. PROGRAM 19 - AVIATION MEDICINE

OBJECTIVES/GOALS: This program is concerned with the analysis, assessment and improvement of the role of the human operator as part of the Air Traffic Control (ATC) System in order to increase its efficiency, reliability and safety.

FY 1982-91 Support of F&E 10 Year Plan

Specific activities in this program include:

- Improve ATC personnel performance and efficiency.
- Develop improved ATCS selection and training techniques.
- Determine relation between various measuring techniques for skill achievement, retention and utilization.
- Evaluate impact of modern technology improvements on maintenance work force.
- Develop techniques for detection, assessment and prevention of unfavorable health changes in ATC specialists.

FISCAL PLAN

FY 82-86	FY 87-91
6,780	9,847

17. PROGRAM 21 - SUPPORT

OBJECTIVES/GOALS: This program provides technical support for solution of overall ATC system problems which do not fall logically into any one of the other development programs. The objectives are to identify requirements for overall ATC system improvements and to conduct analysis and development activities to accomplish objectives related to resolution of system interface problems, development and evaluation of ATC operational procedures, and support to air traffic controller training programs. The specific goals are:

FY 1982-86 Support of F&E 10 Year Plan

- Develop and propose operational ATC procedures and separation standards for helicopter traffic.
- Simulate operational procedures and traffic flow for ATC facilities which require assistance in analyzing the effectiveness of proposed changes to system operations.
- Develop training aids or systems to improve the training of air traffic controllers.
- Identify, document and track issues pertaining to system interfacing and transitioning to the operational ATC system.

FY 1987-91 R,E&D Programs

Apply specialized skills and knowledge of in-house technical staff personnel to identify, analyze and resolve potential problems which would affect overall operations of the ATC system.

Interfaces between current R&D programs and existing field equipments are identified and programs adjusted to insure a smooth transition of programs into the field during the next ten years. Overall support to the various R&D and F&E programs will be provided to insure that:

- ATC procedures are developed for helicopter traffic.
- Simulation support is provided to interface new developments into the operational mode. This includes software maintenance of the various digital simulation facilities at the FAA Technical Center to insure compatibility with current field facilities.
- Continue to identify technical interface requirements for current and future systems.
- Conduct controller productivity studies related to proposed ATC system improvements.

FISCAL PLAN

FY 82-86	FY 87-91
11,215	14,769

APPENDIX III

Research, Engineering and Development
Financial Program Analysis

FY 1982 - 1991

RESEARCH, ENGINEERING AND DEVELOPMENT
FINANCIAL PROGRAM ANALYSIS
FY 1982 - 1991
R,E&D APPROPRIATION
($'s IN 000's)

CURRENT YEAR DOLLARS

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1.	AIR TRAFFIC CONTROL	82,314	175,911	228,150	253,880	194,127	215,232	234,090	251,008	255,834	278,631
01	SYSTEM	13,924	23,890	21,186	31,104	44,748	43,732	52,326	58,830	67,104	71,616
02	RADAR		1,447	536	515	515	10,290	13,770	19,610	12,582	13,428
03	BEACON	7,905	6,642	5,531	5,275	9,190	10,290	12,852	15,688	12,583	13,428
05	AIRCRAFT SEPARATION ASSURANCE	7,060	6,410	5,460	3,510	2,460	3,430	4,590	4,903	7,339	11,190
06	COMMUNICATIONS	8,430	18,431	25,575	12,570	10,125	21,438	23,868	25,493	20,970	17,904
08	AIRPORT/AIRSIDE	4,245	8,236	6,259	8,100	10,700	10,290	11,016	11,766	12,582	13,428
09	AIRPORT/LANDSIDE	360	695	864	1,354	1,848	1,715	1,836	1,961	2,097	2,238
11	ATC SYSTEMS COMMAND CENTER		399	598	2,916	2,916	3,430	4,590	5,883	8,388	6,714
12	EN ROUTE CONTROL	15,885	18,753	22,793	34,506	39,118	36,015	29,376	21,571	25,164	33,570
13	FLIGHT SERVICE STATIONS	4,210	5,394	4,410	4,860	4,007	6,860	11,016	15,688	16,776	17,904
14	TERMINAL/TOWER CONTROL	10,924	18,222	23,298	29,160	41,018	51,450	51,408	47,064	41,940	33,570
16	TECHNOLOGY	7,216	65,397	109,435	117,580	25,052	13,720	14,688	19,610	25,164	40,284
21	SUPPORT	2,155	1,995	2,205	2,430	2,430	2,572	2,754	2,941	3,145	3,357

RESEARCH, ENGINEERING AND DEVELOPMENT
FINANCIAL PROGRAM ANALYSIS
FY 1982 - 1991
R,E&D APPROPRIATION
($'s IN 000's)

CURRENT YEAR DOLLARS

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2. NAVIGATION	12,265	15,518	12,652	16,200	19,400	27,440	31,212	33,337	31,455	29,094
04 NAVIGATION	6,120	8,840	7,303	9,730	12,110	15,435	18,360	19,610	20,970	17,904
07 APPROACH & LAND SYSTEM	6,145	6,678	5,349	6,470	7,290	12,005	12,852	13,727	10,485	11,190
3. AVIATION WEATHER	10,006	12,486	12,136	13,770	11,640	13,720	18,360	29,415	31,455	33,570
15 WEATHER	10,006	12,486	12,136	13,770	11,640	13,720	18,360	29,415	31,455	33,570
4. AVIATION MEDICINE	1,250	1,300	1,350	1,400	1,480	1,715	1,836	1,961	2,097	2,238
19 AVIATION MEDICINE	1,250	1,300	1,350	1,400	1,480	1,715	1,836	1,961	2,097	2,238

SUMMARY

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Air Traffic Control	82,314	175,911	228,150	253,880	194,127	215,232	234,090	251,008	255,834	278,631
Navigation	12,265	15,518	12,652	16,200	19,400	27,440	31,212	33,337	31,455	29,094
Aviation Weather	10,006	12,486	12,136	13,770	11,640	13,720	18,360	29,415	31,455	33,570
Aviation Medicine	1,250	1,300	1,350	1,400	1,480	1,715	1,836	1,961	2,097	2,238
TOTAL	105,835	205,215	254,288	285,250	226,647	258,107	285,498	315,721	320,841	343,533

*U.S. GOVERNMENT PRINTING OFFICE:1981 341-428/511 1-3

The MLS STEP program in FY-82 will include the purchase of approximately 20 airborne systems to expand user participation. Operational evaluation will continue through FY-83.

FY 1987-91 R,E&D Programs

Work will be started in the FY-86-87 time period to extend the MLS capabilities in the terminal areas and to refine designs to reflect advances in technology.

Various approaches for improving the coordination of flight deck information will be undertaken, including the development of a Computer Aided Decisionmaking (CADM) system to improve flight operational safety.

Studies of the man/machine interface and human engineering will be undertaken in relation to the expected evolution of the cockpit display of information.

Specific developments will be undertaken to develop new avionics to integrate and consolidate the presentation of ATC related information including the incorporation of the cockpit display of traffic information transmitted from the ATC system to the aircraft via data link.